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ABSTRACT

To investigate semantic and syntactic variables in the written language of normally hearing and hearing impaired children, 49 hearing impaired and 49 normally hearing children (10-14 years old) were asked to write compositions based on the Accident/Emergency Picture in the Peabody Language Development Kit. In addition, syntactic characteristics were analyzed through the T-unit and syntactic density score and semantic characteristics through propositional analysis and text cohesion analysis. Hearing impaired and hearing Ss performed significantly differently across all language measures. In general, normal hearing Ss produced quantitatively more than hearing impaired Ss. Age differences on syntactic language measures were characterized by a linear development while age differences on semantic measures were characterized by a quadratic trend for both groups. Four factors accounted for 77% of the variance of performance in hearing impaired Ss: the semantic component, syntactic component, hearing/speech component, and cognitive component. (Author/CL)

COMPARATIVE ANALYSES OF NARRATIVE WRITTEN DISCOURSE BETWEEN HRNG AND HRNG IMPAIRED SCHOOL-AGED CHILDREN

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SYNTACTIC AND SEMANTIC CHARACTERISTICS IN THE WRITTEN LANGUAGE OF HEARING IMPAIRED AND NORMALLY HEARING SCHOOL-AGED CHILDREN

Final Report

A DISSERTATION

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

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DOCTOR OF PHILOSOPHY

Field of Communicative Disorders - Audiology and Hearing Impairment

by

Christine Yoshinaga

EVANSTON, ILLINOIS

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ABSTRACT

SYNTACTIC AND SEMANTIC CHARACTERISTICS IN THE WRITTEN LANGUAGE OF HEARING IMPAIRED AND NORMALLY HEARING SCHOOL-AGED CHILDREN

by

Christine Yoshinaga

The goal of this dissertation was to investigate semantic and syntactic variables in the written language of normally hearing and hearing impaired children. Semantic characteristics were analyzed through propositional analysis and text cohesion analysis. Syntactic characteristics were analyzed through the T-unit and syntactic density score. Written compositions were elicited through the use of the Accident/Emergency Picture in the Peabody Language Development Kit from forty-nine hearing impaired and forty-nine normally hearing children at ages ten, eleven, twelve, thirteen and fourteen. All subjects resided in the State of Colorado. The hearing impaired children had severe and profound sensorineural hearing losses with age of onset prior to two years. Hearing impaired subjects were matched to their normally hearing peers on the basis of age, urban/semi-urban status, sex and performance intelligence.

Hearing impaired and normally hearing children performed significantly differently across all language measures. In general, normally hearing children produced quantitatively more than the hearing impaired children. Age differences on syntactic language measures were characterized by a linear development, while age differences on semantic language measures were characterized by a quadratic trend for both groups.

Differences in performance between the hearing impaired and normally hearing children on written language measures disappeared when they were

matched on the basis of reading comprehension ability and age.

Matched solely on the basis of reading comprehension, regardless of age, performance differences on semantic language measures disappeared. Significant age differences remained in the words per T-unit and words per main clause; older children, even when hearing impaired, outperformed younger children.

Four factors accounted for 77% of the variance of the performance in the hearing impaired sample. Factor I, the Semantic Component, included all semantic written language variables. Factor II, the Syntactic Component included the Test of Auditory Comprehension of Language, Test of Syntactic Abilities, and words per T-unit. Factor III, the Hearing/Speech Component, included pure tone average and speech intelligibility. Factor IV, the Cognitive Component included performance intelligence and age.

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CHAPTER I

INTRODUCTION

Since language is typically learned through the use of audition in normally hearing children, it is reasonable to assume that there is a significant relationship between the development of language and loss of hearing. The nature of this relationship has been an area of considerable interest and attention among researchers dealing with the hearing impaired population. Research studies directed towards the investigation of language development in hearing impaired children contain certain underlying hypotheses. The theoretical hypotheses which have guided the organization of this dissertation research are as follows.

First, it is believed that the sense modality through which language is acquired may in fact cause characteristic differences in the acquisition of language: semantics and syntax (Myklebust, 1965). Language symbols and the coding of these symbols are believed to be dependent upon the modality through which language is learned. If this is true, hearing impaired children, with auditory acuity deficits, must rely more heavily upon input from their visual system than do normally hearing children. It is conceivable that the degree to which hearing impaired children involve the visual sense modality could alter their language in both meaning and form. Therefore, the understanding and further investigation of these differences can help professionals better remediate particular language difficulties which hearing impaired children encounter.

Second, it is hypothesized that language processing and productivity is an interactive process. If language is simply an additive system whereby information obtained through an indepth analysis of each component can simply be compiled

with knowledge concerning each additional aspect, then current approaches to the study of language are appropriate. However, a study of parts of a system can only supply a description of the whole if the parts are totally independent of one another and information regarding one sheds no light on the performance in the other. This investigation is based on the premise that a piecemeal approach to the study of language, which considers language as an additive system, is an insufficient explanation of the complexity of language. Rather than a static system, language is an active interplay among components, with semantics and syntax being only two of these components. No part of the system operates independently. The piecemeal or categorical approach misses the heart of this interaction. Therefore, in order to truly study language as an interactive system both semantics and syntax must be studied.

Third, it is believed that semantics should not be studied exclusively on the level of the single word. The function of language is to communicate ideas. Single words and individual sentences both play a role in this purpose, but only in conjunction with sentence to sentence interaction can a message be successfully conveyed. Research into the language of hearing impaired children has ignored this crucial element, the relationship between sentences. This dissertation is an attempt to address the issue. The interaction of meaning at the level of single words within sentences, and between sentences, may provide the information necessary to help educators develop the language skills of hearing impaired children more effectively.

Unfortunately, the study of semantic characteristics of the language of hearing impaired children has been primarily concerned with meaning on the level of the single word. In order to demonstrate the adequacy of current definitions of semantics, the process of language learning by normally hearing children must be

compared to that of hearing impaired children. Language learning by normally hearing children occurs in a natural fashion. Structured rules and categories are not systematically taught, but through experience and a process of discovery the hearing child is able to infer what these rules are and is then able to generate language based upon these structural rules. The amount of learning which occurs, is severely limited if a child is dependent upon the teacher or parent to structure his/her world and to teach him/her every aspect about this world. Hearing impaired children need to learn the tools through which such discovery can take place without direct intervention of the teacher. The average hearing impaired child appears to lack whatever tools are required to facilitate this discovery.

Because of inability to provide the information necessary for such learning to take place, language learning in a hearing impaired population does not seem to be dramatically affected by reading. Knowledge of vocabulary and syntactic structures do not seem to improve measurably from grade to grade. The hearing impaired child does not know how to look for specific categories of information, the logical organization of ideas within read material, or the relationship of one sentence to another. This decoding ability should shape the child's discovery of meaning on the level of the single vocabulary word and on the syntactic level. Therefore, a definition of semantics which encompasses meaning of single words within individual sentences, and between sentences should help to identify how children derive meaning from language.

Fourth, the analysis of written language abilities of hearing impaired children can be used to study the interrelationship between semantics and syntax. A significant relationship between reading ability and the ability to produce written language compositions is believed to exist. Despite much effort, the ability of hearing impaired adults and adolescents to comprehend information conveyed

through printed matter and to communicate ideas through written verbal symbols remains at alarmingly low levels. Data from the 1969 Annual Survey of Hearing Impaired Children and Youth indicated that the mean reading achievement of 10:6-11:6-year-old hearing impaired children on the Primary II battery of the Stanford Achievement Tests was 2.5 grade equivalent. Only one year's advancement, a mean functioning level grade equivalent of 3.5 for the 15:6-16:6-year-old hearing impaired student reflects five years of education and experience. The data correspond to statistics compiled ten years earlier and cited by Furth (1966). The Annual Survey in 1978 yielded almost identical statistics regarding levels and rates of reading achievement (Jensema and Trybus, 1978), indicating that there has been no appreciable change over the last twenty years. Studying how a hearing impaired child expresses himself/herself in written language can provide clues to how he/she is deriving information from printed matter receptively through reading.

Last, the means by which we currently characterize the hearing impaired child's language cannot successfully capture the wide diversity within the hearing impaired population. Therefore, it is proposed that new methods must be established.

Thus, the general purposes of this dissertation are to choose a measure of syntactic competence which is compatible with the theory presented, to broaden the concept of semantics to encompass sentence to sentence interaction, and to select appropriate semantic measures which will accomplish this goal. Finally, the interrelationship between syntax and semantics in the spontaneously generated written language of hearing impaired children as compared with that of their normally hearing peers will be investigated.

There are seven null hypotheses which guide this dissertation.

First, there will be no difference between the written language performance

of the normally hearing school-aged children and the hearing impaired school-aged children.

Second, there will be no difference found among age level performance on the chosen language measures.

Third, there will be no difference in the age trends found among the normally hearing children when compared with hearing impaired children of the same age.

Fourth, there will be no difference among written language measure performance.

Fifth, there will be no difference between hearing impaired children and normally hearing children's performance by written language measure.

Sixth, there will be no significant difference among age trends for each written language measure.

Seventh, there will be no significant change in the interaction of any two of the three variables (handicapping condition, age, and language measure) with the introduction of the third variable.

The written language measures chosen to test these hypotheses are an analysis of clause development, as the measure of syntactic ability, propositional analysis and analysis of text cohesion as measures of semantic ability. The rationale for choice of these analyses, description of each analysis, and the expected results of this research endeavor will be discussed in the following chapter.

CHAPTER II

REVIEW OF THE LITERATURE

Written language and the hearing impaired children is addressed within four topic areas. The first topic area illustrates two needs: (1) the importance of selecting a syntactic measure which will allow comparability with measures of semantic ability and (2) the necessity of broadening the study of semantic characteristics in written language. The second topic area reviews research related to the chosen syntactic analysis, an analysis of clause development. The appropriateness of this technique to the goal of this investigation, the study of the relationship between syntax and semantics in the written language of hearing impaired children, is discussed. The third topic area illustrates how an analysis of narrative discourse allows examination of semantic features beyond the level of the single word. This analysis is accomplished by incorporating semantic characteristics within the context of a sentence by means of a propositional analysis. The semantic characteristics within the body of the text as a whole are investigated by means of a story grammar analysis. The fourth topic area discusses the analysis of text cohesion which provides descriptive information regarding the reference system used within a written text. The usefulness of the information derived from this method is highlighted, since it complements information obtained from the other two systems, analysis of narrative discourse and analysis of clause development. The three techniques described allow a comprehensive evaluation of the written language of hearing impaired children. The summary section presents the expected outcome of the dissertation research in light of the literature reviewed.

Written Language and the Hearing Impairment

The purpose of this section is to synopsize the information currently available about the written language of hearing impaired children. The vast amount of information in the area of syntax is contrasted with the paucity of information with respect to semantics. In addition, the review of this literature demonstrates that there are many unknowns about current information regarding language and hearing impaired children.

Investigations of Syntactic Competence

Prior to the application of transformational grammar theory, written language of the hearing impaired was analyzed syntactically through four types of analyses: error analyses and frequency of usage of various parts of speech, composition length and sentence length.

Two aspects of productivity have been studied: composition length and sentence length. The first type of analysis, composition length, has been found to increase with age (Heider and Heider, 1940; Myklebust, 1965; Goda, 1959; Simmons, 1965; Stuckless and Marks, 1966). However, the differences between normally hearing and hearing impaired children were not significant on this variable. Therefore, although developmentally sensitive, this quantitative measure failed to yield any information concerning qualitative differences between normally hearing and hearing impaired writers.

Although normally hearing and hearing impaired children do not differ significantly in their composition lengths, there is a differnce in the production of their mean sentence length. The second type of analysis, then, is mean sentence length. However, not only does the mean length of sentence tend to increase through middle adolescence in the hearing impaired population, but normally

hearing writers also produce consistently longer sentences than their hearing impaired peers (Heider and Heider, 1940; Myklebust, 1965; Goda, 1959; Stuckless and Marks, 1966). Although any language measure which is sensitive to developmental growth has merit, these measures of productivity must be considered only as gross indicators of linguistic ability, comparable to the mean length of utterance indicators which are used to measure growth in oral expressive language (Brown, 1973) in very young children. Increases in composition length provide information regarding an increase in expressive written vocabulary, since composition length is measured through total word production. However, the correct usage and meaningfulness of these words are not assessed. Hypothetically, a child could simply list unrelated groups of words and demonstrate significant development (increments in mean). Sentence length must at least take word to word relationships into account since some criteria of meaning, as well as rules of syntax govern the definition of a sentence.

The most striking limitation of both composition length and sentence length as language measures is the fact that they do not provide information with respect to quality or complexity of the language produced. Productivity measures suggest that a teacher increase quantity to increase language level. One can readily see that an increase in quantity is too simplistic an explanation of language deficit within the hearing impaired population.

Unfortunately, errors in grammar, spelling and punctuation can seriously affect the constituents of a sentence. The use of a sentence as a unit of measure for productivity can be questioned based on this argument. There is a need for a unit which demonstrates developmental sensitivity within the normally hearing and the hearing impaired populations and which is less dependent upon subjective scoring judgments. Consistency of measurement is crucial if any measure of

language skills is to be used as an indicator of language growth.

Recognizing the need to address the issue of sentence complexity, investigators proposed syntactic-ranking classification systems adapted from those developed by McCarthy (1930). Researchers rated sentences on a continuum from incomplete sentences to elaborate sentence constructions (Walter, 1959; Goda, 1959; Heider and Heider, 1940; Stuckless and Marks, 1966). These studies represented variations on a theme, presenting a variety of different classification systems, but all yielded results characterizing hearing impaired children's written compositions as consisting of incomplete sentences, and simple, subject-verb-object sentence constructions. While capable of describing the sentence construction, these classification systems could not provide additional information with respect to structural rules governing sentence development.

Teaching techniques which developed from these initial studies of sentence complexity were highly structured methods such as the Fitzgerald Key (Fitzgerald, 1949), developed for the purpose of expanding the subject-verb-object level of complexity. Unfortunately, such techniques led to the highly stereotypic sentence constructions which characterize the written language of hearing impaired children to this day.

The third type of analysis was an analysis of errors. A system developed by Thompson (1936) categorizing errors as additions, omissions, substitutions or word order deviations was adapted by Myklebust (1965) to obtain a syntax quotient. Quantitative error counts (Stuckless and Marks, 1966), weighting systems for grammatical errors (Gunderson, 1965) and other adaptations of the Thompson system (Perry, 1968) were used to investigate errors within the written compositions of hearing impaired children.

In general, these studies concluded that hearing impaired children wrote

stories of comparable length, but with shorter sentences than their normally hearing peers. The sentence constructions were simple and stereotypic and, in addition, hearing impaired children made many grammatical errors by adding, omitting, substituting words, and violating word order. While this information provided some comparisons with normally hearing children, the reasons underlying the simplicity and error violations in the language of hearing impaired children remained unclear.

Written language of the hearing impaired was also characterized by the frequency of usage of various parts of speech. Findings have been extremely consistent. Adjectives and adverbs generally increase with age in the hearing impaired population while the use of nouns and verbs decreases. Pronouns, prepositions, adjectives, adverbs and conjunctions are used less frequently by hearing impaired than by normally hearing children (Simmons, 1964; Stuckless and Marks, 1966; Myklebust, 1965; Goda, 1959).

Again, the frequency of usage of parts of speech does not address the issue of rule knowledge or correctness of usage. Because of these limitations, the issue of sentence complexity was again addressed through the transformational grammar theory. The identification of structural rules upon which sentence constructions were based was of primary concern.

Taylor (1969) was the first researcher to apply early transformational grammar theory to the written language of hearing impaired children. The research was an attempt to map the development of the use of transformational grammar rules and was the beginning of contemporary methods aimed at an indepth examination of sentence construction. Taylor demonstrated that hearing impaired children developed understanding of two sub-categorical rules, the noun phrase and the verb phrase. These occurred prior to the use of determiners or auxiliaries.

Initial phrase structure mastery preceded any sentence combining transformations. The use of coordinating conjunctions preceded nominalization, relative clause or adverbial clause use.

Continuing to look at these issues, Ivimey (1976) studied a variety of written language samples from one hearing impaired child, using the more contemporary criterion reference approach. Although no inferences to the population can be made through this case of one study, the detailed approach to sentence complexity demonstrated more efficient and practical information than previous methods. The analysis provided information with respect to the sequence and position of elements within the sentence, consistency of verb usage, indicators of possession, plurality and time. Kretschmer (1972) also applying generative transformational analysis, investigated phrase structure difficulties, a common problem in the language of hearing impaired children. These phrase structure difficulties centered around the use of verbs, articles, and prepositions. Normally hearing subjects exhibited these problems, but to a lesser degree than their hearing impaired peers.

The increased efforts to qualitatively describe the transformational grammar characteristics of written language samples in a hearing impaired population resulted in computer programs which provide indepth analyses of these structures and are now available for the use of educators and researchers (Parkhurst and MacEachron, 1980; Levitt and Newcomb, 1978).

Although not based on spontaneously generated written language samples, the most comprehensive exploration of specific transformational rules has been carried out by Quigley and his associates (Montanelli and Quigley, 1974; Power, 1971; Quigley, Smith and Wilbur, 1973; Quigley, Wilbur and Montanelli, 1974; Wilbur and Quigley, 1972). He studied understanding and use of negation, conjunction, question formation, pronominalization, verbal units, complementation, disjunction and

alternation. Distinctive characteristics not found in the normally hearing population were present in the language of the hearing impaired children. Interestingly, however, the majority of errors of the hearing impaired children were characteristically found in the developing language of younger normally hearing children.

The following are the syntactic errors which are characteristic of hearing impaired children. Five common verb system errors occured. They are: (1) verb deletion, "The dog under the chair"; (2) be or have deletion, "Mary sick"; (3) be-have confusion, "Mary have sick"; (4) incorrect pairing of auxiliary with verb markers, "Mary has pushing the cart"; and (5) by deletion (passive voice), "The girl was pushed the boy." Five complementation errors were evidenced: (1) extra "for", "For to go fishing"; extra "to" in the POSS-ing complement, "Mary goes to playing"; (3) infinitive in place of gerund, "Sally goes to shop"; (4) incorrectly inflected infinitive, "Mary liked to carried picture"; and (5) unmarked infinitive without "to," "Mary wanted go." Two relativization errors were commonly found. They were noun phrases where "whose" is required, "I helped the girl's mother was sick," and copying of the referent, "Mary saw the girl who the girl kicked the ball." Two additional relativization errors occur when the conjunction is used: (1) object-object deletion, "Mary chased the dog and he scared"; and (2) object-subject deletion, "The boy chased the girl had on a red dress."

Four question formation errors appeared in the language of the hearing impaired children: (1) copying, "Who a girl gave you a book?"; (2) failure to apply subject-auxiliary inversion, "Who the child did love?"; (3) incorrect inversion, "Who the play watched?"; and (4) overgeneralization of the negation contraction rule, "I amn't goin. Bill willn't try."

In addition, two characteristic conjunction errors were distinguishing

elements of the language of hearing impaired children: (1) marking only the first verb, "Mary threw the ball and Joe catch it"; and (2) conjunction deletion, "Mary bought ate the pear." Finally, hearing impaired children sometimes use the negative outside the sentence, as in the sentence, "Beth made candy no."

As can be seen by the specificity of the Quigley studies, transformational-grammar analyses leave few questions unanswered in the area of syntactic ability in hearing impaired children. However, even as sophisticated as these methods were, the statement that the syntax facility of a seventeen-year-old hearing impaired child is compareable to that of a normally hearing child of seven years (Myklebust, 1965) remains true. Normally hearing children ceiling on the Test of Syntactic Ability by the age of ten (Quigley, Steinkamp, Power and Jones, 1978), yet mastery of the transformational grammar rules was still not completed in most hearing impaired children by the age of eighteen. The teaching of syntactic rules has produced only very stereotypic sentence structures in the writing of hearing impaired children. Hearing impaired children still fail to recognize that messages can be conveyed in a variety of syntactic forms which seriously impedes their developmental growth in written language facility. Hearing impaired children often fail to spontaneously generate these structures in appropriate contexts, even after comprehension of some transformational rules is demonstrated.

Therefore, although much information about syntactic competence in the hearing impaired population is known, there has been no research which investigates the interrelationship of syntax and semantics in their language. Yet, this interaction, combined with the broadening study of semantics, may provide a key to understanding why indepth analysis of syntax has failed to impact on the rate of language development in hearing impaired children. Unfortunately, only minimal knowledge in the semantic domain is available, in contrast to the

specificity and detail found in the research of syntactic structures.

Investigations of Semantic Competence

Semantic analyses of the written language of hearing impaired children have focused primarily on single word meaning, vocabulary studies. These studies of spontaneously generated written language were counts of word types. Since meaningful use of these vocabulary words or word types did not enter into the analyses, the studies were discussed in the previous section.

Researchers have used two other methods exploring word association. Subjects responded to printed test words by writing the first word that came into their minds (Koplin, Odom, Blanton, Nunnally, 1967; Nunnally and Blanton, 1966). Another approach involved asking subjects to sort words into categories of items with the same or similar meaning (Hughes, 1961). In general, although hearing impaired children knew the meaning of many of the words, they failed to appreciate interrelationships among the words that would have allowed them to place words properly into larger conceptual categories. Therefore, the hearing impaired children were much poorer at word association tasks than the normally hearing children and they also were more limited in the category associations for individual vocabulary items than their normally hearing peers.

The response of educators to word meaning studies such as the ones described above was to teach word categories to hearing impaired children. There was a focus on attribute categories, synonyms, antonyms and multiple meanings. All were single word approaches whose primary limitation was the lack of attention to meaning within the context of written narrative discourse and within the context of the sentence.

Myklebust (1965) designed the only semantic measure of written language composition in the Abstract-Concrete Scale. This scale provides a gross indication

of semantic quality. The composition's abstractness or concreteness is rated on the basis of the text as a whole. Myklebust (1965) is the only investigator to date who has incorporated both measures of syntactic ability and semantic ability beyond the one word level in his linguistic analysis of written language samples. In general, normally hearing children produce a much higher degree of abstraction in their written language as compared to hearing impaired children of the same age.

Kretschmer (1978) reported that he is engaged in the analysis of written compositions through a transformational generative grammar analysis and a case grammar analysis, the results of which are currently unavailable. The case grammar approach is an attempt to examine the semantic relationships within a sentence. However, this type of analysis so closely parallels syntactic analysis that the distinction between the two is unclear. Such attempts are indications within the field of language research that syntax alone cannot provide a complete picture of linguistic competence in the hearing impaired child.

Summary

Although the syntactic competence of hearing impaired children has been explored indepth, their semantic competence as it relates to their syntactic competence is unexplored. While there is specific knowledge with regard to the syntactic errors that hearing impaired children make, the nature of semantic errors is unspecified. Descriptions of semantic competence are limited to statements regarding an overall concreteness and limited vocabulary. There are no studies that address the question of the interrelationship of semantics and syntax in the written language of hearing impaired children. As previously hypothesized, the inclusion of both syntax and semantics may provide the missing elements in current language analysis, thereby revealing why hearing impaired children have so much difficulty learning language. The review of the literature reiterates the claim that

the study of written language in hearing impaired children has become very compartmentalized. It seems that attention to overall meaning rather than single word or individual component analysis is warranted.

The Analysis of Clause Development

Although an analysis of clause development must be considered a measure of syntactic ability, such an analysis can also be thought of as a measure of semantic ability within the context of the sentence, that is, the ability to incorporate many propositions within a single sentence structure through a variety of syntactic forms. The skill requires both syntactic and semantic abilities. Analysis of clause development examines a single unit, much like the sentence. A writer at an elementary stage of clause development can express four or five ideas by means of an equal number of main clauses. On the other hand, a writer utilizing more complex sentence structures can express the same number of ideas within a single clause which included subordinate clauses. Therefore, an analysis of clause development may best complement current analyses of structures via transformational grammar because it allows comparison between groups beyond the mastery of transformational grammar structures and addresses the issue of the flexible use of syntax to convey meaning. Specifically, comparing hard-of-hearing children on transformational grammar structures with more severely hearing impaired children is difficult because hard-of-hearing children frequently ceiling on traditionally used assessments. Clause development analysis, thus, supplies a necessary bridge between semantic and syntactic language abilities within the construction of written narrative discourse.

The analysis of clause structure in written language has been studied in some

detail in the normally hearing population of school aged children. Over the years a number of different analyses have emerged. La Brant (1933) developed the subordination index as a measure of written language maturity. This index compared the proportion of predicates in dependent subordinate clauses with the number of predicates in independent main clauses. Using this approach, clause length was not found to be a developmentally sensitive measure, although the subordination index was. Subsequently, Anderson (1937) evaluated three indices of written language development which addressed subordination, pronoun usage and sentence length. The subordination index did not demonstrate developmental sensitivity in this particular study. However, Heider and Heider (1940) using the same criteria for the subordination index, compared normally hearing and hearing impaired children and found contrary results. Developmental growth was found in both groups by this method. The apparent inconsistency among replication studies appears to be due to different definitions of a subordinate clause.

Some thirty years later, Hunt (1965) proposed an analytic method in which the syntactic unit consisted of one main clause and any subordinate clauses attached to it. He considered this unit grammatically capable of a sentence function and called it the terminable unit or the T-unit. The advantage of this type of analysis over previous approaches was that the unit could be identified objectively and would not be affected by poor punctuation. Hunt's definition of a clause received consensus from grammarians in contrast to the La Brant (1933) definition. Hunt counted as a clause any expression containing a subject or coordinated subjects and a finite predicate or coordinated predicates. La Brant (1933) used "number of predicates" interchangeably with "number of clauses." Further, Hunt's research demonstrated that the T-unit was sensitive to maturation. He identified the following characteristics which increased as a function of age: (1) words per T-unit; (2) word

per clause per T-unit; (3) clauses per T-unit; and (4) words per sentence. Hunt found that clause length was most closely related to chronological age and mental age and that it showed significant performance increments over time.

The T-unit as a measure of clause development has demonstrated developmental sensitivity in all replication studies on written language to date (O'Donnell, Griffin, Norris, 1967; Andolina, 1980). The unit does not provide additional information on types of subordinate clauses and their respective growth rates, although it can illustrate that growth in sentence length occurs as a function of subordinate clause growth.

Following the development of the T-unit analysis, three additional methods were proposed as attempts to provide more precision to the analysis of written language. Botel and Granowsky (1974) proposed a syntactic complexity formula. This method involves a procedure of applying weights of zero to three on specific types of syntactic structures. A simple arithmetic formula is used to determine average syntactic complexity. The weighting of these structures appears to have been arbitrarily assigned and the composite score of syntactic complexity can only be broadly interpreted. The interpretation difficulty is probably the reason this formula is used more as an index of readability than as an index of written language development. Thus far, no statistical evidence has been presented to demonstrate the ability of the syntactic complexity formula to detect development of skills in the area of written language.

Endicott (1973) proposed another model based upon early transformational grammar theory. His theory relies upon a unit which he defines as the co-meme. These units are proposed for a construction of the syntactic scale and are defined below:

Co-meme: A unit of complexity in language consisting of four subcategories: The base co-meme, the syntactic co-meme, the compression co-meme, and the morphemic co-meme.

Base Co-meme: "Those morphemes expressed at a level of language which has a one morpheme per-word ratio.

Syntactic Co-meme: A theoretical syntactic operation by which sentences are combined or altered to achieve efficiency or variation of purpose beyond that achieved at a minimal level of language.

Compression Co-meme: The theoretical morphemic burden of deep structure which is compressed into surface structure through combination or deletion transformations.

Morphemic Co-meme: Morphemes other than those expressed by base comemes, e.g., "The productivity was low." "Productivity" represents one base co-meme; "product," and two morphemic co-memes, "-ive and "-ity" (p. 7).

The complexity ratio was derived by counting the number of co-memes per number of words in any given sentence. O'Donnell (1976) argues that while Endicott's syntactic complexity ratio is able to discriminate one structure from another, it is not so obvious that the ratio would always favor the more mature structures. There is a lack of statistical evidence to support the Endicott theoretical model. Therefore, although both the Botel and Granowsky Syntactic Complexity Score (1974) and the Endicott Syntactic Complexity Ratio (1973) may be useful in descriptive studies, they do not provide the information required by this study. Additionally, even more precise descriptive devices are available for the study of transformational grammar in written language compositions as was reported earlier (Levitt and Newcomb, 1978; Parkhurst and MacEachron, 1980; Ivimey, 1976).

Golub and Kidder (1974) attempted to develop a measure which would provide greater specificity while recognizing the usefulness of the T-unit. The statistical procedures used to validate this syntactic density score are impeccable (O'Donnell, 1975), although the criterion of teachers' judgments of good compositions has been

challenged. They developed the syntactic density score which correlates highly with the T-unit analysis and is able to detect developmental growth in written language skills.

The syntactic density score consists of twelve variables: total number of words, total number of T-units, words per T-unit, subordinate clauses/T-unit, main clause mean word length, subordinate clause mean word length, number of modals, number of "be," "have" forms in the auxiliary, number of prepositional phrases, number of possessive nouns and pronouns, number of adverbs of time, and number of gerunds, participles, and absolute phrases. These variables were isolated through a multiple regression analysis of sixty-three syntactic structures and their relationships with teachers' judgments of writing. Relative weights are assigned to the frequency count of all of the variables except total number of words and total number of T-units. The sum of these weights multiplied by frequency of syntactic forms is divided by the number of T-units in order to obtain the syntactic density score. A grade level conversion can be obtained from the syntactic density score. An example of this tabulation can be found in Table XXXVI, Appendix I.

Thus, the syntactic density score in combination with the T-unit analysis seems to provide the most complete description of syntactic structures within written language in the theoretical framework of clause development.

Since the analysis of clause development is believed to be a good indicator of syntax development for both oral and written language, it has been used extensively to study the relationship between the two. Lull (1929) reported that at the fifth grade level, students write better than they speak. Some time later, Harrell (1975) reported that mean clause length differences between oral and written stories at four age levels were significant, with the mean length greater for oral than written language. The children used more subordinate clauses in writing than in speaking

and this difference increased with age. In addition, they used adverb and adjective clauses more frequently in their writing while they used a greater percentage of noun clauses in their spoken language. O'Donnell, Griffin and Norris (1967) found notable differences between written and spoken syntax control with written language demonstrating the weaker control of syntax in third, fifth and seventh graders. The one important exception to this observation was the coordination of main clauses. This occurred more than three times as often in speech as in writing. Finally, control of syntax in written language of fifth and sixth graders was accelerated far beyond the control seen in speech. Clause development analysis has also been used to determine the syntactic maturity in the oral language of kindergarten, first, second and third grade children (Fox, 1972; Ciani, 1976). The T-unit has been found to be a more efficient measure for charting growth in the oral expressive language of learning disabled children than the syntactic density score (Andolina, 1980).

It is unlikely that the T-unit will replace transformational grammar analysis for developing language in children from birth through eight years of age, because the usefulness of the T-unit begins where measures such as the <u>Developmental Sentence Scoring</u> (Lee, 1972) become less applicable.

Developmental trends in language competence as a function of age and degree of hearing loss are unclear. Unfortunately language measures for those children still developing an understanding for transformational grammar rules are different from those used on children beyond the mastery of these rules. Therefore, linguistic measures most commonly used to analyze the language levels of hearing impaired children are based on transformational grammar theory and can only be compared to normally developing children through ten years of age. The T-unit analysis and the syntactic density score can provide analysis of written

language samples of children with profound through mild hearing losses utilizing the same measure. Interpretation of data and comparability to other populations is possible.

Probably the most practical rationale for choice of the T-unit analysis in conjunction with the syntactic density score as measures of written language is that the educational methods developed for normally hearing children based upon the T-unit analysis, the sentence combining or compacting approaches to written language instruction lend themselves well to the theoretical framework upon which the hypotheses of this dissertation are based (Harrell, 1957; Mellon, 1969; O'Hare, 1971). Language learning occurs best not through structured memorization of language rules and sentence structures but through demonstration of the flexibility and generalizability of language structures to convey the same meaning, irrespective of a child's ability to identify underlying actual grammatical rules.

In summary, the T-unit analysis and the syntactic density analysis appear to be tools that can demonstrate developmental growth without ceiling effects due to age, hearing loss or level of education. Further, it is a unit which is clearly defined allowing for easy, reliable calculation, irrespective of a child's punctuation and grammatical ability. The model upon which clause development is founded focuses on meaning and the use of syntax to convey this meaning. The clause can therefore be considered the building unit for the semantic construction (Halliday, 1977). Thus, an analysis of clause development seems to address the needs outlined earlier. Expansion of the concept of semantics will now be accomplished through discussion of the analysis of narrative discourse.

Analysis of Narrative Discourse

It was suggested earlier that the study of semantics within the field of education of the hearing impaired has focused primarily upon single word meaning. Consequently, it seemed important to broaden the scope of semantic investigation of language within the hearing impaired population to correspond more closely to current psycholinguistic conceptualizations of the semantic component of linguistic competence. Therefore, discussion of the semantic characteristics of the written language produced by young hearing impaired writers will begin with an analysis of semantic relationships within individual sentences and incorporate inter-sentential semantic quality.

The development of a semantic analysis of written narrative discourse must begin with the theory of how information is represented. The expression of written language involves the retrieval of world knowledge from memory which is then communicated through the use of visual and language symbols. Therefore, the way that information is organized and stored will determine the construction and order of written communication. There are no existing, standardized measures which allow for an indepth analysis of semantic relationships and the inferential reasoning incorporated within spontaneously generated written narrative discourse. There is, however, some information on children and adult's comprehension of narrative discourse. Investigators studying the comprehension and recall of stories suggest that a similar organization, structure or schema, may influence the spontaneous generation and construction of novel stories (Stein and Glenn, 1979; Glenn and Stein, in press). Such structure leads us to consider the organization and representation of information on a sentence and discourse level. At this time it appears that the most psychologically useful measure for these theories is found in

propositional analysis.

The propositional code theory posits that information is represented in units of knowledge that can stand as separate assertions (Anderson, 1980). Receptively, a severe to profound-hearing impaired individual acquires information from the environment primarily through the visual modality. This information may be coded through propositions irrespective of the modality of input. There is some evidence in the normal processing literature to suggest that this may occur (Pylyshyn, 1973; Kosslyn and Pomerantz, 1977; and Hays-Roth, 1979). The propositions are additionally free of syntactic restraints; a variety of syntactic structures can be used to express the same meaning. Even an inaccurate syntactic expression is capable of communicating a coherent and appropriate semantic idea.

Propositional analysis deals with semantic representation within sentences. Individual sentences can be comprised of one or more propositions (Anderson and Bower, 1973). Although this investigator has criticized exclusive focus on the single sentence unit in research dealing with syntax, the void of information regarding semantic coding of information for a hearing impaired population demands that initial investigations include semantic analyses at the sentence level as well as on the discourse level. Case grammar analysis has been proposed by Kretschmer and Kretschmer (1978). Propositional analysis can complement information gleaned from case grammar analyses.

Larger and more complex units of knowledge that are composed of collections of images and propositions are referred to as schemas. Schemas organize an individual's knowledge about general categories of objects, classes, events and types of people. These general units of knowledge represent stereotypic sequences, event schemas, or sequences of actions, sometimes referred to as scripts (Schank and Abelson, 1977). They play an important role in the understanding and memory

of stories, by allowing an individual to predict or anticipate what will occur in the succeeding story events (Anderson, 1980). If a story contains information which is contrary to an individual's schema, the individual will distort such information to correspond to his internal structure (Bartlett, 1932). In addition, stories presented in scrambled order and therefore in conflict with an individual's internal schema structure, are less well recalled than those presented in a logical order (Kintsch, 1977). Mandler and Johnson (1977) and Stein and Nezworski (1978) have found that readers who use story schemas demonstrate improved recall of the text or story. The more closely a story conforms to a reader's internal schema, the better the story is recalled (Thorndyke, 1977).

Story schema are acquired through experiences listening to stories as well as life experiences (Mandler, 1978). The hearing impaired child does not have as much experience listening to stories as does the normally hearing child and life experiences are frequently dependent upon input from the visual modality. Due to the effect of the hearing impairment, salient features of an experience may be more determined by the visual and tactile modalities rather than the combined input of auditory-visual stimuli. Hypothetically, it is possible that schemata may be organized differently for a hearing impaired child than for a normally hearing child. These schemata appear to have significant impact upon a child's ability to derive meaning from read material and may even determine what information is absorbed from that material, especially since school children are sensitive to story structure and use that structure to order recall (Stein and Glenn, 1978).

Kintsch and Greene (1978) report that readers write better summaries for stories for which they have appropriate schemata than for stories for which they lack schemata. Culture-specific schema aids both comprehending and reconstructing of stories and this effect is related to the overall organization of the story

rather than to the level of the single sentence. The question of whether or not hearing impairment determines culture-specific schema cannot yet be answered.

Let us suppose, as Myklebust (1965) suggests, that there is a psychology of deafness which differs from a psychology of hearing, that the cognitive bases of semantic memory, the propositional code and schema nodes, differ in a hearing impaired population because these conceptual units are dependent upon and guided by visual and tactile-kinesthetic input rather than auditory-visual input. Language performance and competence in a hearing impaired population may be dictated by a visual rather than auditory-visual base thereby producing a coding system which is neither equivalent, delayed nor disordered, simply different. Kintsch and Greene (1978) speak of culture-specific differences in understanding of stories. Perhaps hearing impairment represents a different experience which grounds its schema in modality-dominated information through the visual system. What may be essential for following the sequence of a story in auditory descriptions may be unnecessarily redundant in a visual schema. In other words, the critical components of a story may not be the same for a hearing impaired child as for a normally hearing child. Story telling may necessitate a description of a visual picture, which may not be as crucial in an auditory language system. Therefore, if information is coded and remembered in propositions and schemas and if these schemata are different in a hearing impaired population, then the current emphasis on syntactic competence may be providing misleading observations concerning the language of hearing impaired children.

If the sentence (clause) is the on-line perceptual unit while the discourse (idea set/logical event space) is the unit of cognitive (semantic) memory (Hurtig, 1978), then language emphasis on syntactic structure, the production unit rather than on the cognitive organizational unit, may have masked the actual cause of delayed

and, as hypothesized, deviant, language in the hearing impaired population. The hypotheses of this dissertation are based on the assumption that a study of narrative discourse in the spontaneous, written language of hearing impaired children will provide more clues to the organization of schema in the hearing impaired population than an investigation of semantic memory and reading comprehension. A logical application of this theory must begin with an analysis of macro and micro propositions within individual sentences (Kintsch, 1974; Turner and Greene, 1976).

Kintsch (1977), Mandler and Johnson (1977) and Thorndyke (1977) have examined the construction of stories and determined that stories have an underlying structure of episodes. Stories have a structure which minimally requires a SETTING, THEME, PLOT AND RESOLUTION (Rumelhart, 1975). Every event or "node" is related by either causal or temporal reltionships. These nodes have also been referred to as macro propositions (Kintsch and Kintsch, 1978) and will be referred to as such here. The Stein and Glenn (1979) story grammar has been chosen as the most appropriate method of analysis for this dissertation, primarily because the analysis is clearly defined and well developed allowing for application to written language samples. Glenn and Stein (in press) have themselves applied this story grammar structure analysis to the written language production of young children. This typical story grammar analysis includes: SETTING and EPISODES (the EPISODES consist of EVENTS, INTERNAL RESPONSE, ATTEMPT, CONSEQUENCE and REACTION) (Stein and Glenn, 1979; Glenn and Stein, in press). Stein and Nezworski (1978) delineate each of these components: the SETTING includes an introduction of the protagonist. It can contain information about physical, social or temporal contexts in which the remainder of the story occurs. The INITIATING EVENT is an action, an internal event, or natural occurrence which

serves to initiate or to cause a response in the protagonist. The INTERNAL RESPONSE can be an emotion, cognition, or goal of the protagonist. An ATTEMPT is an overt action to obtain the protagonist's goal. A CONSEQUENCE is an event, action or endstate which makes the attainment or non-attainment of the protagonist's goal. The REACTION is an emotion, cognition, action or endstate expressing the protagonist's feelings about his goal attainment or relating the broader consequential realm of the protagonist's goal attainment.

In addition, story propositions define the event chain which represents the logical structure or scaffolding of a story, depicting causal inferences necessary for its comprehension. The three formal components in the event chain representation are (1) propositon types, (2) connectives, and (3) connection rules (Warren, Nicholas, and Trabasso, 1978). The seven types of propositions are: STATE, EVENT, ACTION, COGNITION, DISPLAY IMPULSE and GOAL. A STATE proposition is an objective condition of the world environment, of the protagonist, or of another character. STATES may exist either independently of or as the result of a protagonist's action. An EVENT proposition is an objective occurrence or an action by another character. EVENTS may occur either independently of or as the result of the protagonist's action. ACTION and COGNITION propositions can be responses. An ACTION proposition is a voluntary external movement or behavior on the part of the protagonist. A COGNITION proposition is a mental act; a voluntary external movement or behavior on the part of the protagonist. A COGNITION proposition is a mental act; a voluntary internal occurrence or self-induced state on the part of the protagonist. DISPLAY and IMPULSE propositions can be reactions. A DISPLAY proposition is an involuntary external movement or behavior on the part of the protagonist. An IMPULSE proposition is an involuntary internal occurrence or state of the protagonist. A GOAL proposition is a voluntary

or involuntary internal goal held by the protagonist, a state of desiring that a certain occurrence should happen or condition exist (Warren, Nicholas and Trabasso, 1978).

Event chains are also composed of logical connectives: MOTIVATION, PHYSICAL CAUSATION, PSYCHOLOGICAL CAUSATION and ENABLEMENT, TEMPORAL SUCCESSION (then) and TEMPORAL COEXISTENCE (and). These connections are governed by connection rules which refer to the a priori restrictions which constrain permissable combinations of proposition types and connectives. Warren, Nicholas and Trabasso (1978) contend that one such connection rule is that INTERNAL REACTIONS can only be PSYCHOLOGICALLY CAUSED. Descriptions of written language samples of hearing impaired children will provide information regarding the similarity of connectives used and connection rules which govern the scaffolding of the event chain.

Such characterizations of story grammar structure propositions allow for an examination of the inferences necessary for a reader to make if he/she is to comprehend the sequence of the event chain. The application of story grammar analysis which includes episode nodes or story propositions to spontaneously generated written language samples provide a means by which a description of story structure and event chains within a hearing impaired population can be obtained. Unfortunately, story grammar analysis does not lend itself well to statistical comparison with the other methods chosen. It is hoped that this dissertaiton will provide an initial step toward a more complete description of semantic ability. A goal of this dissertation is to demonstrate the importance of propositional analysis types.

The spontaneously generated written language samples of normally hearing children and hearing impaired children will be analyzed through a propositional

analysis within sentences in this study. This method should provide insight into the semantic coding of information in a hearing impaired population as compared to a normally hearing population. This expansion is accomplished by examining meaning intra-sententially.

Analysis of narrative discourse, however, is not the only means to investigate semantic relationships within a written text. The analysis of text cohesion provides information regarding the way in which each description of character, event or episode is cohesively bound together from one specific individual idea to another. This reference system will be discussed next.

Analysis of Text Cohesion

The analysis of narrative discourse through a story grammar approach examines the semantic relationships within the text as a whole. It is a constructive process by which an individual organizes the information to be conveyed in general, non-specific units of information. This structure organizes semantic information so that the idea to be communicated is received in a logical sequence. However, this technique makes no provision for the way in which each description of character, event or episode is cohesively bound together from one specific individual idea to another.

The analysis of cohesion satisfies this role by representing the relationship of sentences to the text. Thus, the analysis of the text as a whole is accomplished by decoding the linkage between individual pieces of information. This system of connective devices allows the reader to follow the logical sequence of events and the flow of information coherently. The concept of text cohesion deals only with the reference system within the text. Both semantics and syntax play interact in a

crucial way in the cohesion of the English language. Cohesion differs from the logical connectives and connection rules described in the discussion of narrative discourse because the focus is upon word-to-word reference between sentences, rather than thought-to-thought or concept-to-concept organization.

Halliday and Hasan (1976) define the concept of cohesion as a semantic one which refers to the relation of meaning that exists within a text and that define it as a text. Any passage, spoken or written, that forms a unified text incorporates cohesion, where the interpretation of one element is dependent upon another element present within the text and cannot be effectively decoded without reference to the presupposed element. This dependency or tie provide continuity between parts of the text. In order for the sentences within a story to truly comprise a story, rather than a series of unrelated sentences, cohesive chains must exist within the body of the text. This semantic system can be achieved either through grammar or through vocabulary (Halliday, 1977).

Halliday and Hasan (1976) speak broadly of contextual references to include exophoric or situation references and endophoric or textual reference. Analysis of cohesion deals only with endophoric refernces, those which refer to an element found within the text. Endophoric references may be either anaphoric (referring to the preceding text) or cataphoric (referring to the succeeding text). The terminology in Halliday and Hasan (1976) becomes somewhat confusing because there is a second use of the word "reference" designating a type of cohesive device. The five types of endophoric textual cohesions are (1) Reference, (2) Substitution, (3) Ellipsis, (4) Conjunction, and (5) Lexical Cohesion. Henceforth, the use of the word "Reference" will apply to one of the five types of textual cohesions.

There are three types of Reference cohesions: (1) personal references such as girl/she or girl/hers, (2) demonstrative references such as /the/, /this/, or /that/,

(3) comparative references as in "the same," "the opposite," "just like the," and "the two ___."

The second type of cohesion, Substitution, occurs through the replacement of one item for another. Only a certain category of word satisfies the requirement of substitution. Three types of substitution are possible: Nominal (My knife is too blunt. I'll get a sharper one.), Verbal (You think Mary knows. Yes, everybody does.), and Clausal (Is there going to be a storm? It says so.).

Ellipsis occurs within the text when an item is replaced by nothing. The three elliptical devices are Nominal, Verbal and Clausal. An example of a nominal ellipsis is: Which hat will you wear? This is the best ___.

There are four types of conjunction cohesions: additive (e.g., and), adversative (e.g., where), causal (e.g., because) and temporal (e.g., when). Lexical cohesions, the fifth type, are the most semantically interesting and include two types: 1) collocation and 2) reiteration. Collocation is a systematic relationship between pairs of words: i.e., antonyms (hot/cold), words drawn from the same ordered series (red/green) or any pair of lexical items in some way associated with the other (laugh/joke, garden/dig, or ill/doctor). Reiteration is a cohesion which relies upon (1) the use of the same word (boy/boy), (a synonym (large/big), or (3) a superordinate (car/Jaguar) or general word (boy/child).

As can be seen in this discussion of the Halliday and Hasan (1976) theory of cohesive devices, both syntax and vocabulary play a significant role in the decoding of connections within a written text. Perhaps this is the reason de Beaugrande (1980) prefers to conceive of cohesion as semantics of syntax or a syntax of semantics. Although de Beaugrande (1980) agrees with the types of cohesive devices presented by Halliday and Hasan (1976), he collapses these types under different categories. The primary differences can be seen in his category status of

recurrence which refers to an actual repetition of expressions and the category status of definiteness. Recurrence is synonymous with the Halliday and Hasan (1976) definition of lexical reiteration, while definiteness is synonymous with the demonstrative reference in the Halliday and Hasan (1976) typology. A category of co-reference refers to the application of different surface expressions to the same element. Co-reference can be either anaphoric or cataphoric and includes all lexical cohesions with the exception of recurrence. De Beaugrande (1980) includes exophora as a type of text cohesion in his theoretical model. There is increasing evidence that exophoric reference occurs within the written text and is crucial to inference decisions made by the reader (Warren, Nicholas and Trabasso, 1979; Stein and Trabasso, in press; Trabasso, Stein and Johnson, in press).

Recall that a theoretical hypothesis of this dissertation is that the semantic coding system and information processing in the hearing impaired population may differ from that of a normally hearing population. A visually coded semantic schema may be a pictorial representation of an event or episode. Reference may seem unnecessarily redundant to an individual who relies primarily upon a revisualization of an event or an imagery recreation of an action sequence. Exophoric reference may in fact be the most crucial element, because the writer may assume that reference does not have to be present in a text, if the reader is using a visual representation system. If hearing impaired individuals retrieve information by visually recreating a schema in their cognition, textual reference may be less important than situational reference. An analysis of text cohesion may thus provide more support to a hypothesis of a difference in semantic coding processes in hearing impaired individuals.

The discussion of text cohesion, thus far, has remained on a theoretical level. The Halliday and Hasan (1976) analysis of cohesion has recently been applied to an

analysis of discourse in oral language (Podhajsky, 1980; Hickmann, 1980). Text cohesion analysis has also been recently applied to spontaneously generated written language samples (Collins, 1980; Erler, 1979; Garber, 1980; Moe, 1978; Starling, 1979). Emphasis has been exclusively upon endophoric text references. The investigation of exophoric text reference may provide the descriptive information which will help to better define how language is processed by a hearing impaired individual.

The definitional categories of Halliday and Hasan (1976) will be used for the purpose of examining the number of cohesive ties and the types of cohesive ties present within the written language of both hearing impaired and normally hearing children. However, the category breakdown proposed by de Beaugrande (1980) in which recurrence is removed from lexical cohesion is more compatible to the hypothesis proposed by this dissertation that text cohesion supplies information with respect to the interaction of syntax and semantics. Therefore, the implications of the results of this investigation will be discussed in the de Beaugrande (1980) framework, as well as Halliday and Hasan (1976).

Summary

Based upon information from the literature, the following hypotheses concerning expected results of the research design were formulated. First, significant differences between normally hearing and hearing impaired children are expected to be found across all language measures. Such findings would replicate previous research findings in the area of language functioning and hearing impaired children.

Second, it is hypothesized that all language measures, text cohesion, clause

development and propositional analysis, will demonstrate significant linear developmental trends, indicating growth with increased chronological age. Studies dealing with syntactic skills within the language of hearing impaired children have demonstrated that a linear development, while very slow, is present.

Third, it is projected that the age trends for the normally hearing children will not differ significantly from the age trends for the hearing impaired children. Previous research has found that although minimal growth was found in the syntactic development of hearing impaired children, it was a depressed reflection of the syntactic development of normally hearing children. It is anticipated that the handicapping condition by age interaction may be non-significant since data from language measures is collapsed, although it has been stated that semantic characteristics may differ from syntactic characteristics.

Fourth, it is hypothesized that significantly different performance on each language measures will be found, indicating that the chosen measures are indicative of a variety of language abilities.

Fifth, it is believed that the normally hearing children and hearing impaired children will evidence different abilities according to whether the measures are syntactic in nature or whether they are indicators of semantic ability. The differences between semantic measures and syntactic measures will be investigated through this interaction. Further, there should be a main effect for the measures factor. A significant interaction between measures and handicapping condition is expected to provide the most interesting information.

Therefore, there should be a significant main effect for handicapping condition on all analyses of variance. In addition, a significant main effect for the factor age and the linear trend analysis on the age factor is anticipated. The interaction between handicapping condition and age is hypothesized to be non-

significant.

Finally, the multiple interaction between handicapping condition, age and measures, will be non-significant.

CHAPTER III

METHOD

The purpose of this investigation was to compare performance measured by analysis of clause development, narrative discourse, and text cohesion for five age groups of normally hearing and hearing impaired children. This chapter discusses the method by which this goal was accomplished.

Subjects

Hearing Impaired Subjects

The hearing impaired subjects included forty-eight school-aged children in each of five age groups: Group I--age 10, Group II--age 11, Group III--age 12, Group IV--age 13, and Group V--age 14. There were ten children in Group I, six in Group II, thirteen children in Group III, twelve children in Group IV and eight children in Group V. All children demonstrated greater than 65 dB pure tone average hearing levels in the better ear. The age at onset of the hearing loss was prior to eighteen months. Therefore, the children were all considered prelingually hearing impaired. All hearing losses were sensorineural in nature. The means and standard deviations of hearing thresholds for the hearing impaired children are shown in Table I. The classroom teacher supplied the audiological information which was recorded in each child's school records. Table II depicts the subjects' speech reception thresholds and Table III shows information regarding their aided speech discrimination scores.

The subjects were free of any handicapping conditions related to visual (except for corrected visual defects), central nervous system dysfunction,

Table I

Pure Tone Averages

Age	Range	Mean	Standard Deviation
10	68-110	93.2	14.9
11	67100	87.8	15.5
12	67-110	92.6	13.9
13	70-105	90.2	12.7
14	70-100	88.8	9.9

Table II

Aided Speech Reception Thresholds

Age	Range	Mean	Standard Deviation
10	25-60	43	14.1
	*4 CNT		
11	28-80	46.3	19.8
12	15-52	38.5	11.1
	*1 CNT		
13	18-55	38.5	10.9
14	25-75	42.9	15.6

*CNT = can not test

Table III

Aided Speech Discrimination Scores

Age	Range	Mean	Standard Deviation
10	16-88 %	52 %	36.0
	*7 CNT		
11	48-84 %	62.7 %	18.9
	*3 CNT		
12	60-91 %	80.3 %	13.8
	*8 CNT		
13	16-80 %	50.9 %	23.6
	*5 CNT		
14	32-76 %	39.3 %	21.9
	*2 CNT		

*CNT = can not test

emotional, physical, and intellectual disorders. All the hearing impaired children had an intelligence quotient of at least 80 on the performance scale of the WISC, WISC-R or some comparable performance test of intelligence as recorded in the school records. The means, standard deviations and ranges are shown in Table IV.

Last, all hearing impaired subjects attended public day schools in the state of Colorado and were educated in either an oral-aural or total communication methodological program. The number of children educated by each methodology is shown in Table V. There were more male children than female children as is characteristic of the hearing impaired population in the United States. Fifty-five percent of the children were male and forty-five percent were female. The distribution is identical to statistics reported for the population as a whole (Jensema and Trybus, 1978). The exact distribution is shown in Table VI.

Normally Hearing Subjects

The normally hearing subjects consisted of forty-nine normally hearing school-aged children matched for age, urban/semi-urban residence, sex, and performance intelligence scores. They were free of the handicapping conditions described earlier. These subjects were students within the Denver city proper and the surrounding suburbs, as were the hearing impaired subjects. The children were chosen to insure that their non-verbal performance intelligence quotients were distributed in the same manner as in the hearing impaired sample. Determination of this criterion was made by the investigator on the basis of their performance on the WISC-R performance scale.

Materials

This study used the Accident/Emergency Picture from the Peabody Language Development Kit for the purpose of eliciting a written language sample. Paper and pencils of the type with which the children were familiar were utilized during the

Table IV

Performance Intelligence Scores

Age		Hearing Impaired	Normally Hearing
10	Mean	110.4	108.9
	SD	10.8	14.3
	Range	(93-123)	(90-124)
11	Mean	110.8	116.7
	SD	17.1	11.8
	Range	(84-131)	(99-138)
12	Mean	105.8	106.2
	SD	16.3	10.5
	Range	(85-134)	(86-120)
13	Mean	105.8	106.2
	SD	14.5	10.5
	Range	(83-122)	(91-121)
14	Mean	98.3	106.7
	SD	13.9	10.9
	Range	(84-122)	(96-120)

Table V

Distribution by Methodology

Oral-aural/Total Communication

Age	N	Oral-Aural	Total Communication
10	10	3	7
11	6	4	2
12	13	7	6
13	12	9	3
14	8	4	4
Totals	49	27	22

Table VI

Distribution by Sex of

Hearing Impaired Children

Age	N	Male	Female
10	10	7	3
11	6	3	3
12	13	8	5
13	12	12	5
14	8	6	2
Totals	49	27	22

testing. The picture depicted an accident scene involving an automobile and a newspaper delivery boy riding a bike. Emergency personnel were at the scene of the accident, in addition to spectators such as pedestrians and shop owners. The single colored picture was chosen to control the schema represented in the visual stimulus. The Myklebust Picture Story Language Test (1965), in contrast, uses a stimulus picture with a more open-ended schema base. Picture stimuli, such as the one chosen for this study, are typically used within the classroom to elicit oral-aural, signed and written language samples in a hearing impaired population.

Procedure

Testers

Fifty testers, comprising educators of the hearing impaired, audiologists and speech/language pathologists (with experience working with hearing impaired children), were selected by the state representative of special education to test the hearing impaired children. The testers were trained in the administration of the written language test through a series of five statewide workshops. The investigator was the trainer for all five workshops. The testers were required to attend three out of the five workshops.

There were two testers for the normally hearing sample, the investigator and a research assistant. The research assistant was trained in the testing procedure using the same guidelines developed for training testers of the hearing impaired sample.

Testing

The study utilized the following procedure for both normally hearing and hearing impaired subjects. The examiner appeared before a group of children holding the Peabody Accident/Emergency Picture so that each child could see it. Each group had an average of eight children. The examiner instructed them with

the language system used within their classroom setting (oral-aural or total communication): "Look at this picture carefully." After a pause of twenty seconds, s/he told them: "You are to write a story about this picture. You may look at it as much and as often as you care to. Be sure to write the best story you can. Begin writing whenever you are ready." The instructions were repeated until the examiner subjectively determined that all the children understood. The picture was then placed in a central position where it could be seen easily. Thereafter, the examiner remained present and available, but in the background. Questions were answered in a neutral manner, indicating that neither help nor further suggestions would be given. If a child asked, "Should I put a title?" the reply was, "If you want to. Write the story the way <u>you</u> think is best." Any questions regarding content were responded to in this way. Infrequently a child said, "I can't write a story." In this event encouragement was given through comments such as, "Try to write something--anything you can think of." The objective of the procedure was to secure the best sample of written language of which the individual was capable, even if it was only a few poorly produced words or phrases. The children were allowed as much time as they needed to complete the story. Most children completed the story in 20-30 minutes. These procedures are similar to those given for the Picture Story Language Test (Myklebust, 1965).

Data Analysis

As discussed previously, the written compositions of both hearing impaired and normally hearing subjects were analyzed in three areas: clause development, written narrative discourse and cohesion. Each of these areas is discussed in the succeeding sections.

Coding

Coders and Criteria

Two speech/language pathologists and the investigator coded the written language samples. The investigator trained the coders in the following procedures. Coding for the propositional analysis was based on requirements delineated by Turner and Greene (1977), Kintsch (1974), and Kintsch (in press). (Appendix I, Table XXXV) No deviations from these criteria were required for this study. The analysis of clause development was coded according to the requirements described by Hunt (1965) for the T-unit analysis and Golub and Kidder (1974) for the syntactic density score. (Appendix I, Table XXXVI) No deviations from these criteria were required for this study. Text cohesion coding was based upon criteria developed by Halliday and Hasan (1976) for the analysis of written texts. (Appendix I, Table XXXVII) No deviations from this system were required for this particular study. All written attempts were coded with the exception of those responses which were incapable of being deciphered and were gibberish, based on the agreement concensus from at least two coders.

Linguistic Coding

Analysis of clause development - syntactic density score and T-unit. The Golub and Kidder (1974) method of clause development analysis described as the Syntactic Density Score was used. Sixty-three syntactic structures were included in the Golub and Kidder study and were put through a process of multivariate analysis. Twelve variables were isolated. These variables correlated significantly with teachers' judgments of written language samples. Through a process of canonical correlation analysis relative weights were assigned to the raw score yielded for each variable according to its contribution to a factor named "syntactic density." In this research study raw data were obtained in thirteen category levels:

(1) number of T-units, (2) words per T-unit, (3) words per main clause, (4) words per subordinate clause, (5) subordinate clauses per T-unit, (6) number of modals, (7) number of "be," "have" forms in the auxiliary, (8) number of prepositional phrases, (9) number of possessive nouns and pronouns, (10) adverbs of time, (11) number of gerunds, participles, and absolute phrases, (12) syntactic density score, and (13) grade level. The specific weights assigned to each category level are shown in Table XXXVI, Appendix I.

Analysis of narrative discourse. The narrative discourse of each written composition was analyzed for the number of propositions which could be identified (Kintsch, 1974; Turner and Greene, 1977; and Kintsch, in press). An example of the propositional analysis of a hearing impaired child is shown in Appendix I, Table XXXV. The data were obtained in three levels: total propositions, number of macro propositions and number of micro propositions. As previously mentioned, this particular type of analysis is a description of the semantic relationships within the individual sentence.

Analysis of text cohesion. The cohesion of the written language samples was analyzed according to Halliday and Hasan (1976). The types of cohesions (endophoric references within the text) were categorized as follows: (1) reference (pronoun, demonstrative and comparative), (2) lexical repetition, (3) collocations (general nouns-verbs, superordinates, synonyms, antonyms, and (4) conjunctions.

Inter-coder reliability. Inter-coder reliability was determined in a pilot study. A criterion of 90% agreement was set in order to continue coding. Five hundred judgments were made on the written language performance of fifteen subjects.

Statistical Analysis

Analysis of the data began with four, three factor, repeated measures.

analyses of variance. The factors were age, handicapping condition and language measures. The following section describes the methods used for answering the research questions in the analysis of clause development.

Analysis of Clause Development

A three-factor repeated measures design S (AxH) x M, subjects nested in (age crossed by handicapping condition) crossed by language measures. The first factor, age, incorporated five levels, ages 10, 11, 12, 13, and 14. The second factor, handicapping condition, incorporated two levels, normally hearing and hearing impaired. The third factor, measures, incorporated nine levels: (1) words per T-unit, (2) words per main clause, (3) words per subordinate clause, (4) number of modals, (5) number of "be," "have," forms in the auxiliary, (6) number of prepositional phrases, (7) number of possessive nouns and pronouns, (8) number of adverbs of time, and (9) number of gerunds, participles and absolute phrases.

The research questions for which these statistical procedures were intended to supply answers were as follows:

1. Does the performance of hearing impaired children differ from that of normally hearing children on language measures of clause development?
2. Does the overall performance of hearing impaired and normally hearing children increase with age on the language measures of clause development?
3. Does the performance of normally hearing children differ from hearing impaired children as a function of age on the language measures of clause development?
4. Is the children's performance on the language measures which incorporate the analysis of clause development different?
5. Do the age differences change according to the language measure?

6. Do the normally hearing and the hearing impaired perform differently according to the measure?

Analysis of Proportions

The second analysis incorporated the three aspects of written language (clause development, narrative discourse and text cohesion) in order to investigate the role of syntax and semantics in the written language of school aged children. The statistical design which allowed the attainment of this goal was a repeated measures analysis of variance, S (A x H) x M, subjects nested in (age crossed by handicapping condition) crossed by measure. The first factor, handicapping condition, included two levels, normally hearing and hearing impaired. The second factor, age, included five age levels (10, 11, 12, 13, 14), as previously described. The third factor, measures, was composed of five levels: (1) macro propositions/ total propositions, (2) micro propositions/total propositions, (3) syntactic cohesions/total cohesions, (4) semantic cohesions/total cohesions, and (5) syntactic density/total syntactic density score. Macro propositions and micro propositions were defined according to the Kintsch (1974) guidelines. Syntactic cohesions were defined as all reference and conjunction cohesions. Semantic cohesions were defined as lexical repetitions and collocations. All proportions were transformed through an arcsine transformation to allow for the use of parametric statistics.

The above analyses were designed to answer the following questions:

1. Does the perfofmance of hearing impaired children differ from that of normally hearing children across all levels of the language measures?
2. Does the overall performance of hearing impaired and normally hearing children increase with age on the levels of the language measures?
3. Does the performance of normally hearing children differ from their hearing impaired peers as a function of age?

4. Do the children perform differently on each of the language measures which incorporate the analysis of proportions?

5. Do age differences change according to the language measure?

6. Do normally hearing and hearing impaired children perform differently according to the language measure?

Analysis of Types

This analysis was designed to investigate the productivity of various elements of clause development, text cohesion and narrative discourse, particularly with respect to the interaction among measures. A three factor, repeated measures design, S (A x H) x M, subjects nested in (age crossed by handicapping condition) crossed by measure, accomplished this goal. The first factor, handicapping condition, was composed of two levels, normally hearing and hearing impaired. The second factor incorporated the five levels of age, 10, 11, 12, 13, and 14. The third factor included eight levels of language measures: (1) number of T-units, (2) number of subordinate clauses, (3) number of macro propositions, (4) number of micro propositions, (5) number of reference cohesions, (6) number of lexical repetitons, (7) number of collocations, and (8) number of conjunctions. Thus, two levels represented clause development, two levels represented propositional analysis, and four levels represented text cohesion.

The above analyses were designed to answer the following questions:

1. Is there a significant difference between the normally hearing and hearing impaired children across all levels of the language measures?

2. Does the performance of all the children on all levels of the measures factor increase with age?

3. Do any differences in age level performance differ according to handicapping condition?

4. Is the performance of the children on each language measure significantly different from their performance on the other language measures?
5. Do the differences by age level change according to the level of the measures factor?
6. Do differences according to handicapping condition differ according to the level of the measures factor?

Analysis of Total Productivity

This analysis represents the most typical way of investigating the written language of hearing impaired children, total word production. In addition, total cohesion and total proposition production were also included in this analysis. The analysis followed the same design as those described previously. Only the levels which incorporated the measures factor changed. The research design was a three factor, repeated measures design, S (A x H) x M, subjects nested in (age crossed by handicapping condition) crossed by measures. Handicapping condition, the first factor, incorporated two levels, normally hearing and hearing impaired. The second factor, age, incorporated the ages 10, 11, 12, 13, and 14--five levels. The third factor, measures, included three levels: (1) total word production, (2) total cohesion production, and (3) total proposition production.

The above analysis was designed to answer the following questions:

1. Is there a significant difference between the performance of the normally hearing and the hearing impaired children across all levels of the measures factor?
2. Is there an overall increase in the children's performance due to age?
3. Does any change in age performance change according to handicapping condition?

4. Is the performance on each level of the measures factor significantly different from the performance on the other language measurement?

5. Do the age differences change according to level of the measures factor?

6. Does the difference between performance of the normally hearing and hearing impaired children change according to level of the measures factor?

All the questions for each of the four analyses were answered through a three factor repeated measures analysis of variance, using the Biomedical Program 4V, for univariate and multivariate analysis of variance. (BMDP4V, 1982) The interactions were investigated through the Welch statistic for multiple comparisons and Bonferroni t-test, Biomedical Program 7D (Dixon, 1982).

Criteria for Rejection of the Null Hypotheses

For each analysis of variance an alpha level of .05 was chosen as the criterion level for rejection of the null hypothesis. When comparing the normally hearing and hearing impaired children, a significant finding on these language measures would not have dramatic impact upon the education of hearing impaired children, since it is an accepted fact that hearing impairment detrimentally affects language development in young children. However, if significant growth was not demonstrated on these language measures in a hearing impaired sample as a function of age, educators might assume that hearing impaired children make no gains in these language areas because of inappropriate teaching methods, leading to a development of new teaching techniques. Such a response is not warranted on the basis of one study. As was demonstrated in the review of the literature there has been a tendency to respond to research in such a way within this field. Therefore, an alpha level of .05 rather than an alpha level of .01 was chosen as the criterion level

for rejection of the null hypothesis.

CHAPTER IV

RESULTS

The goal of this dissertation was to examine the expressive written language of hearing impaired, school-aged children as compared to normally hearing children of the same age, sex, and nonverbal intellectual ability. First, it was hypothesized that language can be best understood only within the context of both semantic and syntactic abilities because the semantic component is a distinct entity from the syntactic component in written language. An interrelationship between these two aspects probably exists. Therefore, the particular language difficulties hearing impaired children exhibit can best be portrayed through the examination of semantics, syntax, and the interplay between the two. The analysis of language skills as individual components--words, phrases, or sentences--was hypothesized to be an incomplete characterization of how language develops in both hearing impaired and normally hearing children. It was proposed that the written text be considered as a wh[illegible] unit, rather than simply sentences or phrases within the whole, without regard for meaning or cohesiveness. Second, it was further hypothesized that the analysis of written language was a particularly useful tool for the investigation of language skills, specifically those which underlie the ability to r[illegible] comprehensively. In other words, a very strong relationship between written l[illegible]age abilities and reading comprehension exists. Third, it was hypothesized that the current means by which language of hearing impaired children is evaluated does not provide detailed and discriminating information regarding language ability in its entirety. It is the contention of this researcher that the semantic aspect of written language is more discriminating than the syntactic aspect. The particular

semantic abilities investigated in this dissertation were hypothesized to provide novel rather than redundant information concerning the language competence of hearing impaired children.

The three general hypotheses are addressed in a variety of analyses. The results of these analyses are divided into four phases. Phase One presents the results of the language measures chosen to represent the semantic, syntactic components of written language and the interrelationship between these two aspects of language. Phase Two presents the results of data regarding the relationship between reading and written language abilities. Phase Three addresses the question of whether the chosen definition of semantic and syntactic abilities truly represent separate skills, and the contribution of each of these components to the characterization of language.

Phase One: Language Measures

Background

In order to accomplish the goal of incorporating semantics and syntax within a single research design, language measures were chosen to represent each of these components. Syntactic ability was evaluated through measures of clause development, the T-unit and syntactic density score. Semantic ability was investigated through a measure of narrative discourse: propositional analysis. The interrelationship of syntactic ability and semantic ability was analyzed through text cohesion which characterizes the linkage or reference system within the narrative discourse.

Analyses. Four analyses of variance comprised the corpus of this research endeavor: (1) an analysis of clause development, (2) an analysis of proportional use

of each of the three components of language, (3) an analysis of productivity of each of the various types which make up the three components, and (4) an analysis of total productivity without regard to type of structure. All but the first analysis include each of the three aspects of language: clause development, propositional usage, and text cohesion.

Design and questions. The research design for the four analyses was the same, S (A x H) x M, subjects nested in (age crossed by handicapping condition) crossed by measure. Only the levels of measure and the components of the measure factor differed from one analysis to the next. The research questions for each analysis were also the same. First, do the language measures discriminate between the written language ability of hearing impaired children as compared to normally hearing children? Second, are the language measures developmental, and to what extent is each language measure developmental? Third, are the language measures developmental for the hearing impaired children as compared with the normally hearing children? Fourth, are the language measures similar or different to each other? Fifth, how do hearing impaired children perform on each measure as compared to normally hearing children? Last, how do hearing impaired children perform on each measure compared to normally hearing children as a function of age?

Univariate analyses. The Biomedical Program 4V provides both univariate and multivariate statistics for repeated measures designs. Only the results of the univariate analyses are reported here. The univariate analysis of variance is robust to violations of the normal distribution. The statistic is also more powerful for small sample sizes. Although one of the assumptions underlying the univariate statistic is homogeneity of variance, which becomes an issue when unequal Ns are employed, the Levene test for equal variances demonstrated that most of the F

tests reported here were derived from distributions demonstrating homogeneity of variance. Therefore, it was decided that violations of goodness of fit to the normal distribution were more detrimental to the use and interpretation of multivariate analyses than slight violations of homogeneity of variance were to the use and interpretation of univariate analyses.

A priori decisons for multiple comparisons. The Levene test of equal variances was chosen to determine the presence of heterogeneity of variance because it is the most appropriate test for small sample sizes and unequal Ns. Both the Bonferroni t-test and the Welch analysis of variance for multiple comparisons were employed to investigate the nature of the significant interactions. The Bonferroni t-test was chosen as the most appropriate means of investigating pairwise comparisons since a specific number of tests could be determined prior to the statistical analyses. The Welch test of analysis of variance was chosen since it represents a conservative test which is not sensitive to violations of homogeneity of variance. Both the t-test and the analysis of variance were performed; the first was used as a comparison of means, and the second as a comparison of variance of the samples.

Analysis of Clause Development

The analysis of clause development was a repeated measures design S (A x H) x M, subjects nested in (age crossed by handicapping condition) crossed by measure. There were five levels of the age factor (10, 11, 12, 13, 14), and two levels of the factor handicapping condition (normally hearing and hearing impaired). There were nine levels of the measures factor: (1) words per T-unit, (2) words per main clause, (3) words per subordinate clause, (4) number of modals, (5) number of be-have

auxiliaries, (6) number of prepositional phrases, (7) number of possessive nouns and pronouns, (8) number of adverbs of time, and (9) number of gerunds, participles and absolute phrases. Of the components of the syntactic density score, only subordinate clauses per T-unit were not included in this analysis. Since this statistic is a proportion, it requires an arcsine transformation which was not comparable with the other data in this analysis. The general purpose of the analysis was to characterize the syntactic ability of the hearing impaired children as compared to their hearing controls.

Table VII shows the summary of the analysis of variance and trend analysis, for clause development. First, there was an overall main effect for age on language performance, as demonstrated by a statistically significant main effect for the factor age (df=4,88; F=3.92; p<.01). A trend analysis was conducted to determine the form of the age level differences. A significant developmental trend was present as evidenced by the statistically significant linear factor (df=1,88; F=7.1; p<.01). Thus, the differences in age level were related to increases in productivity of specific syntactic structures concomitant with increases in age. The quadratic factor was also statistically significant (df=1,88; F=4.6; p<.05), indicating that in addition to the linear development of the syntactic structures, there was also a peak in productivity in the mid years with a drop in productivity in the oldest age group.

Second, there was a statistically significant main effect for the handicapping condition factor. The normally hearing children performed significantly better than the hearing impaired children on these language measures (df=1,88; F=13.38; p<.01). Age differences and significant linear and quadratic trends were present in both groups with no statistically significant interaction between handicapping condition and age (df=4,88; F=2.29; p>.05).

Table VII

Three Factor Repeated Measures Analysis of Variance

Analysis of Clause Development

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Subjects	19601.2	1,88	19601.46	344.46	.0000**
Handicapping Condition	761.3	1,88	761.3	13.38	.0004**
Age	891.2	4,88	222.8	3.92	.0057**
Age linear	403.8	1,88	403.8	7.10	.0092**
Age quadratic	261.9	1,88	261.9	4.60	.0347*
Error	5007.6		56.9		
Handicapping Condition x Age	520.55	4,88	130.14	2.29	.0663
Measures	5224.8	8,704	653.1	51.39	.0000**
Measures x Handicapping Condition	233.3	8,704	29.2	2.29	.0198*
Measures x Age	555.8	32,704	17.4	1.37	.0873
Measures x Age linear	179.2	8,704	22.4	1.76	.1674
Measures x Age quadratic	147.3	8,704	18.4	1.45	.1725
Measures x Age x Handicapping Condition	486.9	32,704	15.2	1.20	.2117
Error	8947.1		12.7		

* = p <.05
** = p <.01

Third, the performance on each language measure was significantly different from overall performance on every other language measure as shown by the statistically significant main effect for the measures factor (df=8,81; F=95.50; p<.001). In addition, there was a statistically significant interaction between the language measures and handicapping condition (df=8,704; F=2.29; p<.05). Due to the number of levels for the language measure, which would necessitate a high number of F-tests using an analysis of simple effects, the analysis of variance for multiple comparisons and the Bonferroni t-test for pairwise comparisons of means were chosen to investigate the nature of the interaction between language measures and handicapping condition. Table VIII represents a summary of the Welch analysis of variance for each level of the measure factor. Table IX shows the results of the Bonferroni t-test comparison of means for each level of the measure factor according to handicapping condition. Using these methods, the performance of the hearing impaired children was found to be significantly different from the normally hearing children on six of the nine measures: words per T-unit, words per main clause, words per subordinate clause, number of prepositional phrases, number of adverbs of time, and number of gerunds, infinitives, participles. The measures on which hearing impaired children performed similarly to normally hearing children were number of modals, number of be-have forms in the auxiliary, and number of possessive nouns and pronouns.

Measures and Handicapping Condition Interaction

Words per T-unit. Normally hearing children produced more words per T-unit than the hearing impaired children. The Welch analysis of variance revealed a significant difference between the normally hearing and hearing impaired groups for the number of words they produced per T-unit (df=1,86; F=22.14; p<.0001). The Bonferroni T-test for pairwise multiple comparisons of means was also statistically

Table VIII

Interaction of Handicapping Condition and Measures

Analysis of Clause Development

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Words Per T-Unit					
Between	150.14	1,86	150.14	22.14	.0000**
Within	650.89		6.78		
Words/Main Clause					
Between	47.05	1,96	47.05	12.37	.0007**
Within	365.23		3.81		
Words Per Subordinate Clause					
Between	40.12	1,96	40.12	7.60	.0080**
Within	506.72		5.28		
Number of Modals					
Between	.65	1,84	.65	.07	.7863
Within	848.41		8.84		
Number of Be-Have					
Between	183.22	1,57	183.22	7.29	.1174
Within	6958.69		72.49		
Number of Prepositional Phrases					
Between	277.81	1,96	277.81	6.21	.0144*
Within	4291.79		44.71		
Number of Possessives					
Between	10.45	1,95	10.45	1.04	.3114
Within	968.65		10.09		
Number of Adverbs of Time					
Between	200.00	1,74	100.00	28.18	.0000**
Within	681.27		7.09		
Number of Gerunds, Participles and Absolute Phrases					
Between	108.26	1,84	108.26	9.14	.0033**
Within	1137.77		11.85		

* = $p < .05$
** = $p < .01$

Table IX

Interaction of Handicapping Condition and Measures

Bonferroni t-test Pairwise Comparison of Means

Analysis of Clause Development

Source	Mean Diff	df	T-Value	P-Value
Words per T-unit	2.48	86.2	4.71	.0000**
Words Per Main Clause	1.39	95.9	3.52	.0007**
Words per Subordinate Clause	1.28	95.7	2.76	.0070**
Number of Modals	.16	84.3	.27	.7864
Number of Be-Have Auxiliaries	2.73	57.4	1.59	.1174
Number of Prepositional Phrases	3.37	95.7	2.49	.0144*
Number of Possessives	.65	95.1	1.02	.3114
Number of Adverbs of Time	2.86	74.5	5.31	.0000**
Number of Gerunds, Participles, Absolute Phrases	2.10	84.1	3.02	.0033*

* = $p < .05$
** = $p < .01$

significant (mean diff=2.48; T-value=4.71; df=86.20; p<.0001).

Words per main clause. Similarly, hearing impaired children produced fewer words per main clause than the normally hearing children. There was a statistically significant difference between groups on the basis of handicapping condition when comparing variances of the groups (df=1,96; F=12.14; p<.001). The mean difference for the groups was also statistically significant as demonstrated by the Bonferroni t-test (mean diff=1.39; T-value=3.52; df=95.89; p<.0001).

Words per subordinate clause. Normally hearing children also produced more words per subordinate clause than the hearing impaired children. The Welch analysis of variance for this measure indicated that a statistically significant difference between groups according to handicapping condition was present (df=1,97; F=7.6; p<.01). Not only the variance of the groups, but also the mean differences of the groups were statictically significant as shown by the Bonferroni t-test (mean diff=1,28; T-value=2.76; df=95.69; p<.001).

Number of modals. Hearing impaired children produce as many modals in their written language as their normally hearing peers. No statistically significant difference was found when comparing normally hearing and hearing impaired children on this measure (df=1,97; F=.07; p>.05). Neither the variance of the groups nor the mean difference of the groups was statistically significant as demonstrated by the Bonferroni t-test (mean diff=.16; T-value=.27; df=84.33; p>.05).

Number of be-have forms in the auxiliary. The production of be-have forms in the auxiliary by hearing impaired children in their written language was similar to that of normally hearing children. The Welch analysis of variance test comparing the variance of the groups on the basis of handicapping condition was not statistically significant (df=1,57; F=2.53; p>.05).

The mean difference between groups was also found not to be statistically significant, as tested by the Bonferroni t-test (mean diff=2.73; T-value=1.59; df=57.4; p>.05).

Number of prepositional phrases. Normally hearing children produce more prepositional phrases than hearing impaired children. A statistically significant difference between the performance of normally hearing children and hearing impaired children was found on this language measure, using the Welch test of analysis of variance (df=1,97; F=6.21; p<.05). The differences between the means of each group were also significantly different as demonstrated by the Bonferroni t-test (mean diff=3.37; T-value=2,49; df=95.7; p<.05).

Number of possessive nouns and pronouns. The production of possessive nouns and pronouns in the written language of normally hearing and hearing impaired children was not significantly different. The Welch test of analysis of variance substantiated this statement, since no statistically significant difference between groups was found (df=1,96; F=1.04; p>.05). The Bonferroni t-test was not statistically significant (mean diff=.65; T-value=1.02; df=95.05; p>.05).

Number of adverbs of time. The normally hearing children produced many more adverbs of time in their written language than the hearing impaired children. The Welch test for analysis of variance indicated a statistically significant difference between the normally hearing and hearing impaired groups (df=1,74; F=28.18; p<.0001). The Bonferroni t-test demonstrated that not only the variance of the groups, but also the means of the groups were significantly different (mean diff=1.86; T-value=5.31; df=74.45; p<.0001).

Number of gerunds, infinitives, participles. Again, on this measure, normally hearing children produced significantly more gerunds, participles and infinitives than the hearing impaired children. The Welch test of analysis of variance

demonstrated the significantly different variances of the groups on this language measure (df=1,96; F=9.14; p<.01). The Bonferroni t-test was also statistically significant (mean diff=2.10; T-value=3.02; df=84.10; p<.01).

Age trends did not differ according to measure, as indicated by a lack of statistically significant interaction between age and measure. There was no significant interaction between the factors measure, handicapping condition and age (df=32,704; F=1.20; P>.05).

Thus, the analysis of clause development showed that, first, clause development is developmental for both normally hearing and hearing impaired children between the ages of ten and fourteen. The age level differences represent both linear increases in production and quadratic age differences, characterized by a peak performance in the mid years. The linear developmental trend and the quadratic age trend differences characterize the subjects' performance on all of the language measures. However, hearing impaired children produce significantly fewer words per T-units, words per main clause, words per subordinate clause, number of prepositional phrases, number of adverbs of time, and number of gerunds, participles and infinitives in their written language than their normally hearing peers. By contrast, they produce similar numbers of modals, possessive nouns and pronouns and be-have forms in the auxiliary as compared with their normally hearing peers. These findings replicate what is currently known regarding the written syntax of hearing impaired children and helps establish the comparability of this sample of children to the existing literature.

Analysis of Proportions

The analysis of proportions was a repeated measures design, S (A x H) x M,

subjects nested in (age crossed by handicapping condition) crossed by measure. There were five levels of age (10, 11, 12, 13, 14) and two levels of the handicapping condition factor (normally hearing and hearing impaired). There were five levels of the factor measure: (1) macro propositions/total propositions, (2) micro propositions/total propositions, (3) syntactic cohesions/total cohesions, (4) semantic cohesions/total cohesions, (5) syntactic density/highest possible syntactic density score. The proportions were transformed using the arcsine transformation. In order to include syntactic density in this analysis, it was necessary to transform the score to a proportion for comparability with the other data. The use of proportions reduced the variability among groups which was present for all measures of productivity.

Table X shows the summary of this analysis of variance for the proportions. First, age level performance on these proportions was not significantly different. There was no main effect for the factor age ($df=4,88$; $F=1.15$; $p>.05$). Second, the performance of normally hearing children differed significantly from the performance of hearing impaired children on these proportions. A statistically significant main effect for the factor handicapping condition ($df=1,88$; $F=17.36$; $p<.001$) was found. Neither normally hearing children nor hearing impaired children performed differently on the proportional measures of language performance according to age. The interaction between age and handicapping condition was found not to be statistically significant ($df=4,88$; $F=1,87$; $p>.05$). Since there was no significant interaction between age and handicapping condition, the language performance differences between normally hearing and hearing impaired children may not be attributed to a developmental delay for the hearing impaired children between the ages of ten and fourteen.

Third, the performance on each proportion used to measure written language

Table X

Three Factor Repeated Measure Analysis of Variance

Analysis of Proportions

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Subjects	773488.	1,88	773488.	80046.	.0000**
Handicapping Condition	167.7	1,88	167.7	17.36	.0001**
Age	44.3	4,88	11.1	1.15	.3402
Age linear	29.8	1,88	29.8	3.08	.0826
Age quadratic	.18	1,88	.18	.02	.8913
Handicapping Condition x Age	72.2	4,88	18.1	1.87	.1231
Error	850.3		9.7		
Measures	46779.0	4,352	11694.7	183.72	.0000**
Measures x Handicapping Condition	2816.2	4,352	704.1	11.06	.0000**
Measures x Age	841.5	16,352	72.6	.83	.6555
Measures x Age linear	514.9	4,352	128.7	2.02	.0908
Measures x Age quadratic	120.1	4,352	30.0	.74	.7566
Measures x Age x Handicapping Condition	893.1	16,352	55.8	.88	.5965
Error	22406.1		63.7		

* = p < .05
** = p < .01

abilities, differed significantly from performance on the other proportions. There was a statistically significant main effect for the measure factor (df=4,85; F=279.26; p<.0001). Not only was there r   ence in age level performance overall, across proportions, but also no age   erences were found for individual proportions. There was no statistically significant interaction between the language measures and age (df=16,352; F=.83; p>.05).

Fourth, the performance on the language measures differed according to handicapping condition. There was a statistically significant interaction between measure and handicapping condition (df=4,85; F=8.32; p<.0001). The specificity of this interaction was investigated through the Welch analysis of variance (Table XI) and the Bonferroni t-test (Table XII).

Measure x Handicapping Condition Interaction

Macro propositions/Total propositions. Hearing impaired children used a greater percentage of macro propositions in their written language than did normally hearing children. The Welch test for analysis of variance was statistically significant for this variable (df=1,73; F=27.18; p<.0001).

Micro propositions/Total propositions. Normally hearing children produced proportionately more micro propositions in their written language than did hearing impaired children. There was a statistically significant difference between the variance of the groups according to handicapping condition, as demonstrated by the Welch test of analysis of variance (df=1,73; F=32.66; p<.0001). The means of the two groups were also significantly different according to the Bonferroni t-test (mean diff=6.79; T-values=5.72; df=72.51; p<.001).

Syntactic cohesions/Total cohesions. Normally hearing children oduced proportionately more syntactic cohesions, consisting of demonstratives and pronoun references than the hearing impaired children. There was a statistically significant

Table XI

Interaction of Handicapping Condition and Measures

Analysis of Proportions

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Macro Propositions/ Total Propositions					
Between	926.65	1,73	926.65	27.18	.0000**
Within	3273.16		34.09		
Micro Propositions/ Total Propositions					
Between	1128.06	1,73	1128.06	32.66	.0000*
Within	3315.44		34.54		
Semantic Cohesions/ Total Cohesions					
Between	276.46	1,91	276.46	3.76	.0557
Within	7067.82		73.62		
Syntactic Cohesions/ Total Cohesions					
Between	363.65	1,93	363.65	5.11	.0261*
Within	6828.59		71.13		
Syntactic Density					
Between	137.53	4,41	34.38	.87	.4922
Within	4062.28		43.68		

* = $p < .05$
** = $p < .01$

Table XII

Interaction of Handicapping Condition and Measures

Bonferroni t-test Pairwise Comparison of Means

Analysis of Proportions

Source	Mean Diff	df	T-Value	P-Value
Macro Propositions/ Total Propositions	-6.15	72.9	-5.21	.0000**
Micro Propositions/ Total Propositions	6.79	72.5	5.72	.0000**
Syntactic Cohesions/ Total Cohesions	3.85	92.9	2.26	.0260*
Semantic Cohesions/ Total Cohesions	-3.36	91.2	-1.94	.0557
Syntactic Density	5.07	96.0	3.62	.0005**

* = $p < .05$
** = $p < .01$

difference between the groups by handicapping condition on this variable, as demonstrated by the Welch test of analysis of variance (df=1,97; F=5.11; $p<.05$). The Bonferroni t-test showed that not only the variance of the sample groups, but also the mean difference was statistically significant (mean diff=3.85; T-value=2.26; df=92.85; $p<.05$).

Semantic cohesions/Total cohesions. The proportionate number of semantic cohesions (lexical repetitions and collocations) to the total number of cohesions produced was similar in both hearing impaired and normally hearing groups. No significant difference was found on the proportional usage of semantic cohesions using the Welch test of analysis of variance (df=1,97; F=3.76; $p>.05$). The Bonferroni t-test for pairwise comparison of means was also not statistically significant (mean diff=-3.36; T-value=-1.94; df=91.20; $p>.05$).

Syntactic Density Score/Total Score Possible. Normally hearing children had higher syntactic density scores/total syntactic density score possible than their hearing impaired peers. The overall syntactic ability of hearing impaired children was significantly less than the normally hearing children. The Welch test of analysis of variance demonstrated the significant difference statistically (df=1,97; F=13.10; $p<.001$). The mean difference of the groups was also statistically significant, as indicated by the Bonferroni t-test (mean diff=5.07; T-value=3.62; df=96; $p<.001$).

Last, the interaction between any two of the three factors, measure, age and handicapping condition, did not change at any level of the third variable. There was no statistically significant interaction between measure, age, and handicapping condition (df=16,260; F=.59; $p>.05$). The differences due to measure, age and handicapping condition were consistent overall.

Thus, the proportional analysis revealed, first, that no developmental trends

in the written language of either normally hearing or the hearing impaired children was present. Second, the written language of hearing impaired children is characterized by proportionately more macro propositions and proportionately fewer micro propositions than the normally hearing children. Hearing impaired children also produce fewer syntactic cohesions proportionately than do their normally hearing peers. The overall syntactic density scores are significantly lower in the hearing impaired children indicating poor syntactic skills than the normally hearing children.

Analysis of Types

The types of propositions, cohesive devices, and syntactic structures produced were studied with a repeated measures design, S (A x H) x M, subjects nested in (age crossed by handicapping condition) crossed by measure. There were five levels of the factor age (10, 11, 12, 13, 14), and two levels of the handicapping condition factor (normally hearing and hearing impaired children.). There were eight levels of the measure factor: (1) number of subordinate clauses, (2) number of T-units, (3) number of macro propositions, (4) number of micro propositions, (5) number of reference cohesions, (6) number of lexical repetition cohesions, (7) number of collocation cohesions, (8) number of conjunction cohesions. Types of propositions, types of cohesions and types of syntactic forms were included in this analysis to investigate the interaction among these three variables.

The results indicated in Table XIII, the analysis of variance, revealed a number of findings. First, there were significant age group differences, as measured by the significant main effect for the factor age ($df=4,88$; $F=3.36$; $p< .05$). In order to examine the nature of the age effect, both a linear trend analysis and a

Table XIII

Three Factor Repeated Measures Analysis of Variance

Analysis of Types

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Subjects	165239.0	1,88	165239.	207.04	.0000**
Handicapping Condition	4593.93	1,88	4593.93	5.76	.0185*
Age	10716.4	4,88	1679.10	3.36	.0132*
Age linear	2247.72	1,8	2247.72	2.82	.0969
Age quadratic	6507.55	1,88	6507.55	8.15	.0054**
Handicapping Condition x Age	6622.8	4,88	1655.69	2.07	.0909
Error	70231.18		798.08		
Measures	80453.2	7,616	11490.7	81.91	.0000**
Measures x Handicapping Condition	10836.0	7,616	1548.01	11.04	.0000**
Measures x Age	8463.26	28,616	302.26	2.15	.0006**
Measures x Age linear	2335.55	7,616	333.65	2.38	.0210*
Measures x Age quadratic	369.52	7,616	527.93	3.76	.0005**
Measures x Age x Handicapping Condition	5716.80	28,616	204.17	1.46	.0623
Error	86411.93		140.28		

* = p <.05
** = p <.01

quadratic trend analysis were performed. No linear developmental trend was found. The linear trend analysis for the age effect was non-significant (df=1,88; F=2.82; p>.05). However, an overall quadratic trend on the age factor was found to be statistically significant (df=1,88; F=8.15; p<.01). The effect of age reached a peak at twelve and thirteen years, with lower performance at the ten, eleven, and fourteen year age groups.

Second, there was a statistically significant main effect for handicapping condition (df=1,88; F=5.76; p <.05). The hearing impaired group was less productive than the normally hearing group. In addition, the age group differences were common to both normally hearing and hearing impaired children. There was no significant interaction between handicapping condition and age (df=4,88; F=2.07; p>.05). The significant difference between age groups which followed a quadratic trend was characteristic of both normally hearing and hearing impaired groups.

Third, the children performed differently on the types of propositions, types of cohesions and types of syntactic forms with a statistically significant difference among measures (df=7,616; F=81.91; p <.0001). More important, there was also a significant interaction between measures and handicapping condition (df=7,82; F=5.63; p<.0001). The nature of this interaction was investigated through the Welch test of analysis of variance for multiple comparisons. These findings are depicted in Table XIV. The Bonferroni t-test for pairwise comparisons of means is summarized in Table XV.

<u>Measures x Handicapping Condition Interaction</u>

<u>Number of subordinate clauses.</u> [illegible]nally hearing children produced more subordinate clauses than the hearing impaired children. There was a statistically significant difference between groups on this measure (df=1,97; F=5.80; p<.05). The mean difference between groups was also statistically significant as

Table XIV

Interaction of Handicapping Condition and Measures

Analysis of Types

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Number of Subordinate Clauses					
Between	130.19	1,81	130.29	5.80	.0183*
Within	2158.20		22.48		
Number of T-units					
Between	5.40	1,96	5.40	.09	.7654
Within	5784.65		60.26		
Number of Macro Propositions					
Between	1242.87	1,83	1242.87	4.46	.0378*
Within	26769.17		278.85		
Number of Micro Propositions					
Between	13377.81	1,67	13377.81	10.25	.0021**
Within	125288.82		1305.09		
Number of Reference Cohesions					
Between	121.23	1,96	121.23	.70	.4062
Within	16724.24		174.21		
Number of Lexical Repetition					
Between	251.52	1,88	251.52	3.37	.0699
Within	7172.53		74.71		
Number of Collocation					
Between	205.76	1,76	205.76	10.21	.0020**
Within	1934.08		20.15		
Number of Conjunction Cohesions					
Between	45.81	1,92	45.81	1.89	.1729
Within	2330.53		24.28		

* = $p < .05$
** = $p < .01$

Table XV

Interaction of Handicapping Condition and Measures

Bonferroni t-test Pairwise Comparison of Means

Analysis of Types

	Mean Diff	df	T-Value	P-Value
Number of Subordinate Clauses	2.31	80.6	2.41	.0183*
Number of T-units	47	95.6	.30	.7654
Number of Macro Propositions	7.12	83.4	2.11	.0377*
Number of Micro Propositions	23.37	67.4	3.20	.0021**
Number of Reference Cohesions	2.22	95.9	.83	.4062
Number of Lexical Repetition Cohesions	-3.20	87.6	-1.83	.0699
Number of Collocation Cohesions	3.20	75.7	3.20	.0020**
Number of Conjunction Cohesions	1.37	91.6	1.37	.1729

* = $p < .05$
** = $p < .01$

demonstrated by the Bonferroni t-test (mean diff=2.31; T-values=2.41; df=80.63; $p < .05$).

Number of T-units. The hearing impaired and normally hearing children's production of number of T-units was similar. There was no significant finding when comparing normally hearing and hearing impaired children on this measure (df=1,97; F=.09; $p > .05$). The Bonferroni t-test was also found to be non-significant (mean diff=.47; T-value=.30; df=95.62; $p > .05$).

Number of macro propositions. Normally hearing children produced significantly more macro propositions than their hearing impaired peers. The variances of the groups were statistically significant as demonstrated by the Welch test of analysis of variance (df=1,83; F=4.46; $p < .05$). The mean difference between groups on the basis of handicapping condition was also significant statistically as shown by the Bonferroni t-test (mean diff=7.12; T-value=2.11; df=83.4; $p < .05$).

Number of micro propositions. Normally hearing children also produce significantly more micro propositions than their hearing impaired peers. The variances of the groups were statistically significant as demonstrated by the Welch test of analysis of variance (df=1,67; F=10.25; $p < .01$). The mean difference between groups on the basis of handicapping condition was also significant statistically as shown by the Bonferroni t-test (mean diff=13.37; T-value=3.20; df=67.4; $p < .01$).

Number of reference cohesions. The production of demonstratives and pronoun reference cohesions in the written language of hearing impaired children and normally hearing children was not significantly different. The Welch test of analysis of variance on this variable was found to be non-significant (df=1,88; F=3.37; $p > .05$), as was the Bonferroni t-test (mean diff=2.22; T-value=.83; df=95.86; $p > .05$).

Number of lexical repetitions. In a similar fashion, hearing impaired children produced similar amounts of lexical repetitions cohesions when compared to their normally hearing peers. No statistically significant difference between groups was found using the Welch test of analysis of variance ($df=1,88$; $F=3.37$; $p>.05$). The Bonferroni t-test was also non significant (mean $diff=3.20$; $T\text{-value}=-1.83$; $df=87.56$; $p>.05$).

Number of collocations. Normally hearing children produced significantly more collocation cohesions than the hearing impaired children. The Welch test of analysis of variance indicated that the variance of the groups was statistically significant ($df=1,76$; $F=10.21$; $p<.01$). The Bonferroni t-test was also found to be statistically significant (mean $diff=2.90$; $T\text{-value}=3.2$; $df=75.67$; $p<.01$).

Number of conjunction cohesions. Hearing impaired children produced as many conjunction cohesions in their written language as the normally hearing children. The Welch test of analysis of variance was found to be non-significant ($df=1,92$; $F=1.89$; $p>.05$), as was the Bonferroni t-test (mean $diff=1.37$; $T\text{-value}=1.37$; $df=91.62$; $p>.05$).

The measure by handicapping condition interaction demonstrates that the normally hearing and hearing impaired children differed significantly on their performance on number of macro propositions, number of micropropositions, number of collocations and number of subordinate clauses.

Fourth, the children performed differently on the measures as a function of age ($df=18,197$; $F=1.59$; $p<.05$). The effect was present for both normally hearing and hearing impaired groups because there was not a significant interaction among the factors. Some of the measures did demonstrate a developmental trend, as indicated by the significance of the linear trend analysis on the age linear x measure interaction ($df=7,616$; $F=2.38$; $p<.05$). The quadratic trend was present for

the majority of the language measures, but not for all of the language measures. This was shown by the statistical significance of the age quadratic trend interaction with the measures factor (df=7,616; F=3.76; p<.001). The nature of this interaction was investigated through the Welch analysis of variance test. (Table XVI)

Six of the variables demonstrated significant age differences: (df=1,97; F=2.67; p<.05), umber of T-units (df=4,97; F=2.97; p<.05), number of macro propositions (df=4,97; F=2.79; p<.05), number of micro propositions (df=4,39; F=4.35; p<.01), number of reference cohesions (df=4,97; F=3.65; p<.01), and number of lexical repetition cohesions (df=4,42; F=2.81; p<.05). The variable, collocation cohesions, although statistically differing by age group performance, demonstrated an unusual age trend, a quartic trend (df=4,40; F=2.92; p<.05). Conjunction cohesion productivity did not differ significantly according to age (df=4,41; F=2.58; p>.05). A linear developmental age trend was only present for the number of subordinate clauses and number of micro propositions.

These analyses indicated that normally hearing and hearing impaired children perform differently on language measures of types of propositions, types of cohesions and types of syntactic forms. Although an overall linear developmental trend was not found, a significant quadratic age trend characterized the age differences. Both normally hearing and hearing impaired children demonstrated similar age trends. The differences between groups on the basis of handicapping condition were dependent upon specific language measures. Hearing impaired children produced significantly fewer subordinate clauses, macro propositions, micro propositions, and collocation cohesions. However, both normally hearing and hearing impaired children produced similar quantities of conjunction cohesions, reference cohesions and repetition cohesions.

Table XVI

Interaction of Age and Measures

Analysis of Types

Source	Sum of Squares	df	Mean Square	F-Values	Tail Proba-bility
Number of Sub. Clauses					
Between	236.1	4	59.0	4.35	.005**
Within	205[illegible].4	41	22.1		
Number of T-uni					
Between	619.6	4	154.9	3.54	.0145*
Within	170.5	40	55.6		
Number of Mac Propositions					
Between	3000.3	4	750.1	4.45	.0044**
Within	25011.9	41	268.9		
Number of Mic Propositio					
Between	12030.7	4	3007.7	4.35	.0053**
Within	126635.8	39	1361.7		
Number of Reference Cohesions					
Between	2283.5	4	570.9	5.26	.0017**
Within	14561.9	40	156.6		
Number of Lexical Repetition					
Between	693.1	4	173.3	2.81	.0372*
Within	6730.9	42	72.4		
Number of Callocation					
Between	152.5	4	38.1	2.92	.0330*
Within	1987.4	40	21.4		
Number of Conjunction					
Between	163.9	4	40.9	2.58	.0513
Within	2212.4	41	23.8		

* = p <.05
** = p <.01

Analysis of Total Productivity

The analysis of total productivity also utilized a repeated measures design S (A x H) x M, subjects nested in (age crossed by handicapping condition) crossed by measure. There were five levels of the factor age (10, 11, 12, 13, 14) and two levels of the factor handicapping condition (normally hearing and hearing impaired). There were three levels of the measure factor: (1) total words, (2) total number of propositions, and (3) total number of cohesions.

Table XVII shows a summary of the analysis of variance. First, the children's performance differed according to age group. There was a statistically significant main effect for the factor age ($df=4,88$; $F=1.79$; $p<.05$). Second, there was a statistically significant main effect for the factor handicapping condition ($df=1,88$; $F=482$; $p<.05$). The hearing impaired children produced significantly fewer words, propositions and cohesions than the normally hearing children. Similar to the findings in the analysis of types of propositions, cohesions and syntactic forms, no overall developmental age trend was found as indicated by the fact that the linear trend analysis on the age factor was non-significant ($df=1,88$; $F=2.81$; $p>.05$). The age differences were, however, characterized by an overall quadratic function. This was shown by the statistically significant finding for the quadratic trend analysis on the age factor ($df=1,88$; $F=4.96$; $p<.05$). Moreover, hearing impaired children generally produced fewer words, propositions and cohesions at each age level. However, this finding was not consistent for the age twelve group. For this one age, hearing impaired children produced quantitatively more on these language measures than their normally hearing peers. There was a statistically significant interaction between handicapping condition and age ($df=4,88$; $F=2.90$; $p<.05$). This interaction is best demonstrated through a graph of the means for the three

Table XVII

Three Factor Repeated Measures Analysis of Variance

Analysis of Total Productivity

Source	Sum of Squares	df	Mean Square	F-Values	Tail Proba-bility
Subjects	.1489	1,88	.1489	169.12	.0000**
Handicapping Condition	41850.	1,88	41850.	4.75	.0320*
Age	96747.9	4,88	24187.0	2.75	.0333*
Age linear	24796.0	1,88	24796.0	2.81	.0969
Age quadratic	43668.4	1,88	43668.4	4.96	.0285*
Handicapping Condition x Age	103012.	4,88	25753.0	2.92	.0254*
Error	775187.9		8808.9		
Measures	332140.	2,176	166070.	135.13	.0000**
Measures x Handicapping Condition	17023.5	2,176	8511.8	6.93	.0013**
Measures x Age	29599.3	8,176	3699.9	3.01	.0034**
Measures x Age linear	29599.3	2,176	3270.4	2.66	.0727
Measures x Age quadratic	13224.8	2,176	6612.4	5.38	.0054**
Measures x Age x Handicapping Condition	21838.7	8,176	2729.8	2.22	.0280*
Error	216296.8		1228.9		

* = $p < .05$
** = $p < .01$

language measures at each age level by handicapping condition. Figure I shows the interaction.

Third, there was a statistically significant main effect for the language measures (df=2,17; F=133.73; p<.0001). As expected, the children produced different amounts of total words, propositions and cohesions. More important, there was a significant interaction between measure and handicapping condition (df=2,176; F=7.15; p<.01). The difference in productivity when comparing normally hearing and hearing impaired children changed at various levels. Although the two groups differed significantly on their total word production, normally hearing children and hearing impaired children produced similar quantities of propositions and cohesions. The nature of this interaction was investigated through the Welch test of analysis of variance for multiple comparisons (Table XVIII) and the Bonferroni t-test for pairwise comparisons of means (Table XIX).

Measure x Handicapping Condition Interaction

Total Words. Overall, hearing impaired children produced fewer words in their written stories than did their normally hearing peers. There was a statistically significant difference between the performance of the two groups on this language variable (df=1,97; F=4.73; p<.05). Not only the variance of the groups, but also the mean difference was statistically significant as shown by the Bonferroni t-test (mean diff=42.45; T-value=2.17; df=74.64; p≤.05).

Total Propositions. In contrast, normally hearing children and hearing impaired children's total number of propositions produced were similar in quantity. The Welch test of analysis of variance was found to be non-significant (df=1,70; F=2.92; p<.05). In addition, the mean difference between groups was non-significant as demonstrated by the Bonferroni t-test (mean diff=18.31; T-value=1.71; df=69.77; p>.05).

handicapping

Table XVIII

Interaction of Handicapping Condition and Measures

Analysis of Total Productivity

Source	Sum of Squares	df	Mean Square	F-Values	Tail Proba-bility
Total Words					
Between	44146.94	1,75	44146.94	4.73	.0329*
Within	896867.84		9342.37		
Total Propositions					
Between	8210.29	1,70	8210.29	2.92	.0919
Within	269944.2041		2811.92		
Total Cohesions					
Between	587.76	1,96	587.76	.71	.4008
Within	79216.25		825.17		

* = $p < .05$
** = $p < .01$

Table XIX

Interaction of Handicapping Condition and Measures

Bonferroni t-test Pairwise Comparison of Means

Analysis of Total Productivity

Source	Mean Diff	df	T-Value	P-Value
Total Words	42.45	74.6	2.17	.0329*
Total Propositions	18.31	69.8	1.71	.0919
Total Cohesions	4.90	95.5	.84	.4008

* = $p < .05$
** = $p < .01$

Total Cohesions. Likewise, the production of total cohesions by normally hearing and hearing impaired children was similar. The variance of the two groups was not significantly different statistically (df=1,97; F=.71; p>.05). The Bonferroni t-test demonstrated that the mean difference was not statistically significant (mean diff=4.90; T-value=.84; df=95.54; p>.05).

Fourth, the age differences changed according to the language measure analyzed. This was shown by the statistically significant interaction between the factors age and measure (df=8,174; F=7.61; p<.0001). The Welch Multiple comparisons analysis of variance test was used to investigate the significance of the age by measure interaction. (Table XX) This was shown by the statistically significant interaction between the factors age and measure (df=8,174; F-7.61; p<.0001). The production of total words and total cohesions changed according to age levels, while the production of total propositions was similar at the various age levels. This was illustrated by the statistically significant difference found for the total words (df=4,40; F=4.62; p<.01), and for the total cohesions (df=4,93; F=2.81; p<.05). No statistically significant difference for the factor age was found on the total propositions (df=4,97; F=2.38; p>.05).

Finally, there was a significant interaction between measure, handicapping condition and age (df=4,87; F=3.3, p<.05, Table XXI) Hearing impaired children produced more total propositions than their normally hearing peers only at the twelve year age group.

Summary of Phase One Results

In summary, overall differences between the performance of normally hearing and hearing impaired children on these language measures were found. In general,

Table XX

Interaction of Age and Measures

Analysis of Total Productivity

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Total Words					
Between	93713.01	4,40	23428.25	4.62	.0037**
Within	847301.77		9110.77		
Total Propositions					
Between	25855.23	4,40	6463.81	2.31	.0742
Within	252299.27		2712.89		
Total Cohesions					
Between	9817.04	4,41	2454.26	4.84	.0027**
Within	[illegible]9986.96		752.55		

* = $p < .05$
** = $p < .01$

Table XXI

Interaction of Handicapping Condition and Age

Analysis of Total Productivity

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Total Words					
Loss	47638.21	1	47638.21	5.73	.0188*
Age	93713.00	4	23428.25	2.82	.0298*
Interaction	71587.84	4	17896.96	2.15	.0809
Error	731566.9917	88	8313.26		
Total Propositions					
Loss	11506.39	1	11506.39	5.09	.0265*
Age	25855.23	4	6463.81	2.86	.0279*
Interaction	45296.65	4	11324.16	5.01	.0011**
Error	198792.3205	88	2258.00		
Total Cohesions					
Loss	1008.13	1	1008.13	1.41	.2380
Age	9817.04	4	2454.25	3.44	.0117*
Interaction	62845.93	88	714.16	2.29	.0656

* = p < .05
** = p < .01

the normally hearing children produced quantitatively more than their hearing impaired peers. This difference in performance found by handicapping condition was present at each age level. Significant age differences characterized all productivity measures. However, no change in performance by age was evident when proportional usage, rather than quantitative productivity measures were utilized. The trends characterizing the age differnces were language dependent. Syntactic components as measured by the clause development analysis were characterized by an overall linear developmental trend. The semantic components, as measured by text cohesion and propositional analysis, were characterized by quadratic age trends. This quadratic age trend was also present in syntactic components, as evidenced in the analysis of clause development. In contrast, the linear development was not found to characterize the semantic components of the written language. The different age trends found according to language measures were parallel in both the normally hearing and the hearing impaired groups.

The reduced productivity which characterized the hearing impaired group, was not found on all language measures. Similar quantities were produced by both normally hearing and hearing impaired children on the following language measures: number of modals, number of possessive nouns and pronouns, number of be-have forms in the auxiliary, number of conjunction cohesions, number of reference cohesions, number of lexical repetition cohesions, number of T-units and number of total propositions.

Finally, as shown by the analysis of proportions, the written language of hearing impaired children was characterized by proportionately more macro propositions and proportionately fewer micro propositions and syntactic cohesions than the normally hearing children. These differences were consistent at each age level. For the analysis of proportions, no change in performance was found

according to age level. This finding in the analysis of proportions differed from the age level trends evidenced in the analyses which dealt with productivity rather than proportions.

Phase Two: The Relationship Between Reading and Written Language

Phase One demonstrated the sensitivity of the language measures to the written language abilities of normally hearing and hearing impaired children. The results provided specific information concerning the nature of the differences in the written language of normally hearing and hearing impaired children. However, the analyses revealed nothing about the relationship of these language measures to reading ability. Since the measures provided information which is compatible with that gleaned from previous research studies, the relationship between the language measures and the ability to comprehend written language was investigated. It was hypothesized that the written language measures were highly related to reading comprehension and that more knowledge concerning the abilities tapped by these language measures might shed light on why hearing impaired children encounter so many difficulties learning to read. The method used to investigate the relationship between written language and reading is discussed in the following section.

Background

Reading Assessment. A rapid assessment of general reading level, the cloze procedure, the Paragraph Comprehension subtest of the Woodcock-Johnson Psychoeducational Battery was given to each subject (Appendix II, Table XXXVIII). The procedure is a reading assessment technique which requires children to respond with a single word to fill in a blank within sentences. The measure is an indication of general reading level. It does not provide indepth information diagnostically

concerning the reading process.

Statistical Analysis. Four analyses of variance, using the Biomedical Program 4V (BMDP4V-82), were performed: (1) analysis of clause development; (2) analysis of proportions, (3) analysis of types, and (4) analysis of total productivity. Since age was now a matching variable, the design of each of these analyses of variance was S (H) x M, subjects (nested in handicapping condition) crossed by measure. For each analysis of variance an alpha level of .05 was chosen as the criterion level for rejection of the null hypothesis. The rationale for choice of this alpha level was discussed in Chapter Three: Methods.

The research questions for which these statistical procedures were intended to supply answers were as follows:

1. Does the performance of hearing impaired children differ from that of normally hearing children on language measures incorporated in 1) the analysis of clause development, 2) the analysis of types, 3) the analysis of proportions, and 4) the analysis of total productivity?
2. Does the overall performance differ according to language measure?

It was hypothesized that such a close relationship existed between written language skills and reading ability that no significant differences between the groups (normally hearing and hearing impaired) would be found for either those matched by age and reading, or those matched on the basis of reading ability alone.

Reading and Age Matched Pairs

Subjects. Recall that the subjects included in the analyses of variance in Phase One were matched on the basis of age, performance intelligence, sex, urban/semi-urban status and racial distribution. It was, however, impossible to match the entire sample on the basis of reading ability, since the range of reading skills within the hearing impaired sample was considerably broader than the

normally hearing sample and most reading scores of the hearing impaired children were between first and third grade achievement levels. The normally hearing sample, however, demonstrated reading ability more consistent with their age and grade level.

Nine hearing impaired children were matched on the basis of their chronological age and scores from the Paragraph Comprehension subtest to nine normally hearing children. Due to the overall depressed reading scores within the hearing impaired sample, only nine hearing impaired children of the forty-nine hearing impaired children included in Phase One had reading scores which were within the range of the scores of the normally hearing controls.

Results. As hypothesized, the measure factor in all four analyses was significant, which replicated the findings reported in Phase One. However, all effects due to handicapping condition disappeared. The results of each of the four analyses of variances are summarized on Tables XXXVIII-XLI, which are in Appendix II. Tables XXII-XXV show the performance of the normally hearing and hearing impaired children for each of the language measures included in these analyses. The means, standard deviations and ranges are reported in these Tables.

Thus, hearing impaired children write similarly to normally hearing children for both semantic and syntactic components of language, when they are matched by age and reading level.

Matched Pairs on Reading Alone

Unfortunately, it is usually impossible to match hearing impaired children and normally hearing children on the basis of age and reading scores, primarily because hearing impaired children evidence such depressed reading ability. The children matched by age and reading ability all demonstrated at least a third grade level of reading ability. Therefore, more commonly, hearing impaired children are matched

Table XXV

Normally Hearing and Hearing Impaired Children

Matched by Age and Reading

Analysis of Total Productivity

		Total Words	Total Propositions	Total Cohesions
Hearing Impaired	Mean	132.0	58.2	49.6
	SD	90.7	40.7	36.3
	Range	(32-296)	(13-122)	(14-126)
Normally Hearing	Mean	118.0	54.8	45.1
	SD	62.2	36.3	23.6
	Range	(52-231)	(17-118)	(15-80)

to normally hearing children solely on the basis of reading ability irrespective of age. Additionally, it is important to study whether the age variable is a critical factor when investigating written language abilities.

Subjects. Eight hearing impaired children (12, 13, 14 years of age) and eight normally hearing children (9, 10 years of age) were matched on the basis of their paragraph comprehension scores. There was at least a three year difference in age between the hearing impaired children and their matched controls.

Results. As hypothesized, there was no significant effect of handicapping condition on (1) analysis of proportions (Table XLII, Appendix II), (2) analysis of types (Table XLIII, Appendix II), or (3) analysis of total productivity (Table XLIV, Appendix II). However, on the analysis of clause development, there was a significant interaction between measure and handicapping condition ($df=8,112$; $F=2.52$, $p<.05$), as shown in Table XXVI, indicating that some differences were present between the performance of the younger normally hearing children and the older hearing impaired children on individual language measures.

The nature of this significant interaction was investigated through the Welch statistic for multiple comparisons analysis of variance (Table XXVII), and the Bonferroni t-test (Table XXVIII).

Measure by Handicapping Condition Interaction

The older hearing impaired children produced more words per T-unit than the younger normally hearing children ($df=1,10$; $F=6.87$; $p<.05$). Similarly the older hearing impaired children also produced more words per main clause than the younger normally hearing children ($df=1,4$; $F=6.10$; $p<.05$). The performance of the normally hearing children and the hearing impaired children did not differ significantly on any of the other levels of the measure factor. The results were as follows: (1) words per subordinate clause ($df=1,14$; $F=.00$ $p>.05$), (2) number of

Table XXVI

Two Factor Repeated Measures Analysis of Variance

Analysis of Clause Development

Groups Matched by Reading Only

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Subjects	2656.54	1,14	2656.54	170.25	.0000**
Handicapping Condition	30.71	1,14	30.71	1.97	.1824
Error	218.46		15.6		
Measures	1082.37	8,112	135.29	28.81	.0000**
Measures x Handicapping Condition	94.61	8,112	11.83	2.52	.0148*
Error	525.98		4.69		

* = $p < .05$
** = $p < .01$

Table XXVII

Interaction of Handicapping Condition and Measures

Multiple Comparisons

Groups Matched by Reading Only

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Words per T-Unit					
Between	27.04	1	27.04	6.87	.0255**
Within	55.09	10	3.94		
Words Per Main Clause					
Between	20.70	1	20.70	6.10	.0269**
Within	47.48	14	3.39		
Words Per Subordinate Clause					
Between	.02	1	.02	.00	.9714
Within	164.24	14	11.73		
Modals					
Between	3.06	1	3.06	3.21	.1070
Within	13.38	9	.9554		
Be-Have Auxiliaries					
Between	6.25	1	6.25	1.06	.3212
Within	82.75	14	5.91		
Prepositional Phrases					
Between	39.06	1	39.06	3.37	.0878
Within	162.38	14	11.59		
Possessives					
Between	1.56	1	1.56	.47	.5057
Within	46.88	14	3.34		
Adverbs of Time					
Between	27.56	1	27.56	3.54	.0807
Within	108.88	14	7.78		
Gerunds, Participles					
Between	.06	1	.06	.01	.9081
Within	63.38	14	4.53		

* = $p < .05$
** = $p < .01$

Table XXVIII

Interaction of Measures and Handicapping Condition

Bonferroni t-test

Analysis of Clause Development

Source	Mean Diff	df	T-Values	P-Values
Words per T-unit	-2.60	10.1	-2.62	.0254*
Words per Main Clause	-2.28	9.3	-2.47	.0348*
Words per Subordinate Clause	- .06	12.7	- .04	.9715
Number of Modals	- .88	9.2	-1.79	.1063
Number of Be-Have Auxiliaries	-1.25	12.08	-1.03	.3240
Number of Prepositions	-3.13	13.0	-1.84	.0894
Number of Possessives	- .63	13.8	- .68	.5058
Number of Adverbs of Time	2.63	7.9	1.88	.0968
Number of Gerunds, Participles, Absolute Phrases	- .13	14.0	- .12	.9081

* = $p < .05$
** = $p < .01$

modals (df=1,9; F=3.21; p >.05), (3) number of be-have forms in the auxiliary (df=1,14; F=1.06; p >.05), (4) number of prepositionsl phrases (df=1,14; F=3.37; p >.05), (5) number of possessives (df=1,14; F=.47; p >.05), (6) number of adverbs of time (df=1,14; F=3.54; p >.05), and (7) number of gerunds, participles and absolute phrases (df=1,14; F=.01; p >.05). Tables XXIX to XXXII are included to demonstrate means, standard deviations and ranges for each language measure.

In summary, when reading level is third grade level or above, and hearing impaired children are matched to normally hearing children on the basis of age and reading scores, all differences in performance on written language measures due to hearing loss disappear. However, when hearing impaired children are matched to younger normally hearing children solely on the basis of their reading ability, they differ in the number of words per T-unit and the number of words per main clause. The older hearing impaired children produced significantly more words per T-unit, and more words per main clause than the younger normally hearing children. The words per T-unit and words per main clause are developmental such that older hearing impaired children outperform younger normally hearing children, even when reading levels are matched. Thus, there is a close relationship between reading level as measured by the Paragraph Comprehension subtest of the Woodcock-Johnson Psychoeducational Battery and measures of written language. There appears to be a stronger relationship between reading level and the semantic written language component, than between reading level and the syntactic written language component, since the syntactic component appears to develop with age.

In conclusion, the findings of the analysis of clause development for the groups matched on the basis of reading alone provided results contradictory to the hypothesis that written language and reading abilities are highly related regardless of age. It appears that those written language variables which measure syntactic

Table XXX

Normally Hearing and Hearing Impaired Children

Matched by Reading Alone

Analysis of Total Productivity

		Total Words	Total Propositions	Total Cohesions
Hearing Impaired	Mean	74.1	37.8	28.9
	SD	32.2	19.8	13.9
	Range	(33-108)	(15-80)	(11-54)
Normally Hearing	Mean	122.8	53.9	48.6
	SD	86.8	37.1	36.9
	Range	(43-296)	(20-122)	(18-126)

skills are more closely related to age than reading.

Phase Three:
Factors Accounting for Variance Within the Hearing Impaired Sample

One purpose of this study was to choose measures of semantic and syntactic ability which were related, yet distinct, providing information regarding the particular differences in the written language of normally hearing children and their hearing impaired peers. Phase One demonstrates that the language measures chosen successfully differentiated children with severe and profound losses and those with normal hearing on written language performance. Phase Two showed the relationships of these language measures to reading. In the hearing impaired sample, reading was so highly related to the written language measures that all differences between normally hearing and hearing impaired children in their written language performance disappeared when the children were matched on the basis of reading ability. However, neither Phase One nor Phase Two addressed the question of whether these measures of syntax and semantics represent unique aspects of language not currently tapped by traditional means of evaluating the language of hearing impaired children. Therefore, it was critical to demonstrate that the measures that are sensitive to the extreme variability which characterizes the language of the hearing impaired children are, in fact, more sensitive and informative than other language measures now used for this purpose. Furthermore, the measures should provide other than redundant information about the language abilities of hearing impaired children. Phase Three attempted to substantiate the hypothesis that analysis of semantic variables, such as propositional analysis and text cohesion analysis, in conjunction with their relationship to syntactic elements,

is crucial to the understanding of how language develops within a hearing impaired population.

In order to accomplish this goal, a factor analysis was performed on the hearing impaired sample. Included within this analysis were variables representing auditory ability, speech intelligibility, intelligence, age, receptive syntactic ability (TACL), receptive written syntactic ability (TSA), expressive written syntax (words per T-unit), expressive written semantic ability (macro propositions and micro propositions), and expressive written syntactic/semantic ability (total cohesions and collocations).

Twelve variables were included in the factor analysis of the hearing impaired sample. The purpose of the factor analysis was to examine the contribution of these measures to an understanding of hearing impaired children's written language and their relationship to measures and variables currently used to characterize hearing impaired children and their language.

Subjects and Measures

Thirty-one complete cases were used for this study. Identifying information was provided by the classroom teachers from each student's school record. Other measures of language and speech were administered within the same time frame as the written language measure, by the same testers who were trained in the same fashion as described in the Methods chapter. The twelve variables were: (1) pure tone average, (2) speech intelligibility (the Clark Speech Test), (3) performance intelligence, (4) age, (5) hours of special education intervention, (6) Test of Syntactic Ability (TSA), (7) Test of Auditory Comprehension of Language (administered oral-aurally or through total communication, depending upon the particular methodology familiar to each hearing impaired child), (8) words per T-unit, (9) number of macro propositions, (10) number of micro propositions, (11) total

cohesions, and (12) number of collocations. The measures of written language chosen for this factor analysis were those which were the best discriminators between normally hearing and hearing impaired children (information from Phase One).

Data Analysis

The data was analyzed with Biomedical Program 4M, Factor Analysis (BMDP4V-82). Table XXXIII shows the four factors, their eigenvalues and the cumulative proportion of the total variance explained by each factor.

The analysis showed that four factors accounted for seventy-seven percent of the variability within the hearing impaired sample. The rotated factor loadings greater than .500 are reported. Table XXXIV shows the sorted rotated factor loadings for each variable which is included in Factors I through IV.

Factor I: the Semantic Component. Factor I, which will be named the Semantic Component, accounted for thirty-six percent of the variance within the sample. The variables identified as representative of this factor are: (1) total cohesions (factor loading = .962). (2) macro propositions (factor loading = .909), (3) micro propositions (factor loading = .909), and (4) number of collocations (factor loading = .775). All other variables had factor loadings less than .500. Although words per T-unit is clearly not the same indice as measures of narrative dicourse or text cohesion, there is a relationship between this syntactic measure and the Factor I, Semantic Component.

Factor II: The Syntactic Component. Factor II, which will be called the Syntactic Component, accounted for nineteen percent of the variance. The variables which comprised this factor are: (1) words per T-unit (factor loading = .797), (2) Test of Syntactic Ability (factor loading = .775), (3) Test of Auditory Comprehension of Language (factor loading = .76), and (4) hours of special

Table XXXIII

Eigenvalues and Proportion of Variance Accounted For

Factor	Eigenvalues	Cumulative Proportion of Total Variance
1. Semantics	4.36	.36
2. Syntax	2.25	.55
3. Hearing/Speech	1.59	.68
4. Cognitive Performance	1.06	.77

Table XXXIV

Sorted Rotated Factor Loadings

	Factor I	Factor II	Factor III	Factor IV
Total Cohesions	.962	.000	.000	.000
Macro Propositions	.922	.000	.000	.000
Micro Propositions	.909	.300	.000	.000
Collocations	.775	.423	.000	.000
Words/T-unit	.308	.797	.000	.000
TACL	.000	.796	.000	.000
TSA	.000	.775	.000	.000
HRS	.000	-.598	.000	-.407
PTA	.000	.000	.889	.000
Speech Intelligibility	.000	.369	-.846	.000
IQ	.000	.000	.000	.825
Age	.000	.000	.000	-.765

education (factor loading = -.598).

Factor II included expressive, written syntactic ability, receptive written syntactic ability and receptive oral-aural/total communication syntactic ability. This factor is inversely related to the number of hours of special education services, indicating that the higher the level of achievement on these variables, the fewer the hours of service that are provided. Teachers, clinicians and staffing teams seem to use syntax as a measure of whether or not to provide service to hearing impaired children. In addition, there was some relationship between three other variables and Factor II. Although the variables were not representative of the corpus of Factor II, since the factor loadings were less than .500, the factor loadings were greater than .250 indicating a relationship to Factor II. The three variables were: (2) micro propositions (.300), (2) number of collocations (.423), and (3) speech intelligibility (.369). Therefore, Factor II, representing the Syntactic Component has a relationship to narrative discourse, text cohesion and speech intelligibility.

Factor III: The Hearing/Speech Component. Factor III, which will be called the Hearing/Speech Component, accounted for nine percent of the variance. Only two variables were included in this factor. They were: (1) pure tone average (factor loading = .889), and (2) speech intelligibility (factor loading = -.846). Interestingly, no other variables had factor loadings greater than .25 which indicates that the component of hearing/speech ability is not highly related to the semantic or syntactic variables of written language. Predictably, there is an inverse relationship between hearing ability and speech ability, indicating that as the hearing deficit increases, the speech ability decreases and vice versa.

Factor IV: The Cognitive Performance Component. Factor IV, which will be called the Cognitive Performance Component, accounted for nine percent of the

variance within the sample. The three variables identified as incorporating this factor are: (1) performance intelligence (factor loading = .825), (2) hours of special education (-.407), and (3) age (-.765). No other variables had factor loading greater than .25. The unusual negative factor loading of -.765 for the variable age is explained by the particular make-up of the hearing impaired sample. As shown in Table IV (Chapter III), the performance-intelligence scores for the hearing impaired sample decreased somewhat with age, although the scores were all within normal limits. The fourteen-year-old children had lower mean performance intelligence scores than the ten-year-old children in the sample. There was a negative relationship of hours of special education services to Factor IV and a positive relationship of performance intelligence. As intelligence scores increase, hours of special education service tend to decrease.

Interestingly, age was not highly related to the semantic component, syntactic component or hearing/speech component. In addition, performance intelligence represented a separate factor, not related to the semantic component, syntactic component, or hearing/speech component.

In summary, the variance within the hearing impaired sample was most clearly captured by the semantic written language measures (narrative discourse and text cohesion). This component is clearly separate from the syntactic component which is the language aspect most commonly measured in the hearing impaired population. However, a relationship between the two components does exist. Together, the language components account for fifty-five percent of the variance within the sample. Hearing/Speech abilities play a role in the larger amount of variance within the hearing impaired sample, but are not highly related to the language components. Together, language, hearing and speech account for sixty-eight percent of the variance within the hearing impaired sample.

Performance intelligence was also identified as an important variable, but was not as discriminating as language or hearing/speech abilities.

Summary

Phase One provided information related to the sensitivity of the language measures chosen in discriminating between normally hearing and hearing impaired children. Quantitatively these analyses of variance also highlighted particular characteristics of the written language of hearing impaired children which were different from that of their normally hearing peers.

Phase Two demonstrated the important relationship between reading ability and written language ability. On the whole, differences in written language ability which differentiate hearing impaired children from their normally hearing peers, disappear when they are matched according to reading ability. However, some indices of syntactic ability are more related to age than to reading or hearing level, since younger children demonstrate poorer syntactic ability than older children, even when the younger children read at similar levels of comprehension and the younger children are normally hearing and the older children are hearing impaired.

Phase Three demonstrated that the language measures chosen do, indeed, represent different aspects of language than are currently investigated. Furthermore, the semantic language measures are responsible for greater variance within the written language abilities of school-aged children than syntactic measures, although a clear relationship between syntactic written language abilities and semantic written language abilities does exist. Syntax and semantics represent distinct aspects of language functioning in written language.

Therefore, it is concluded that semantic measures of written language

provide valuable and more discriminating information about the written language abilities of hearing impaired children than syntactic measures. Semantic measures of written language are highly related to the reading comprehension of hearing impaired children. In addition, they are not redundant information and are not currently tapped by those diagnostic tools which are traditionally used to describe hearing impaired children.

CHAPTER V

DISCUSSION

The goal of this dissertation was to provide information about language which would be useful in broadening the current operational definition of language used as the basis of developing diagnostic assessment tools and curricula for hearing impaired children. The model presented was based upon a description of language which included, initially, two critical components--syntax and semantics. It was proposed that indepth examination of either component could provide only segmented information and that this information could not be fully understood without knowledge about the interaction between the two components. In addition, it was hypothesized that the definition of semantics needed to be expanded to include more than single word meaning. An observation about previous research and studies dealing with language and hearing impairment was that most studies emphasized syntactic skills, almost to the exclusion of semantic abilities. While an abundant fund of information is available concerning the characteristics of syntactic development, the delays and disorders which characterize language of hearing impaired children, there is an amazing lack of information regarding the role of meaning within the language of hearing impaired children.

It was proposed that an expansion of the definition of semantics within the written language of children, either normally hearing or hearing impaired, should include the use of propositional analysis and analysis of text cohesion. It was also proposed that the most useful organization of syntactic information, when examining the relationship of semantics and syntax within the written language of hearing impaired children, was the analysis of clause development. Through the use

of these tools, it was hoped that the interaction between syntax and semantics within written language discourse could be analyzed more effectively.

Although clause development has not been utilized much for the purpose of investigating language characteristics of hearing impaired children, it was hypothesized that this method could provide information which was in concordance with other measures of syntactic ability now utilized within the educational field. Furthermore, it was hypothesized that investigations of written language could provide some clues concerning the reading difficulties of hearing impaired children, because the relationship between reading and writing was very strong.

The following discussion attempts to describe the contribution of this research project to the understanding of written and read language within the hearing impaired population. The results of this dissertation will be discussed with respect to each phase. Phase One provides information concerning the interaction, similarities, and differences found about the language measures chosen to analyze the written narrative discourse of the normally hearing and hearing impaired children. Phase Two provides information about the relationship between reading and writing. Phase Three is an investigation of the factors which influence variability within the hearing impaired population. The discussion will end with implications for future research.

Discussion of Phase One

The discussion of Phase One will be accomplished by addressing answers to each of the research questions generated for this research project, and the contribution of each analysis of variance to the individual questions. Since the particular measures, including propositional analysis and text cohesion analysis

have not been used previously to analyze the characteristics of written language in a normally hearing population, several interesting findings have implications to the population as a whole, even though the major thrust of the research was directed toward a better understanding of language skills within a hearing impaired population.

Question I.

Is there a significant difference between normally hearing and hearing impaired children across all measures? As hypothesized, normally hearing and hearing impaired children performed differently on each of the four analyses. The chosen language measures were effective in discriminating between performance of hearing impaired children and their normally hearing peers providing information which substantiates previous research endeavors and provides novel information. Overall productivity with relation to clause development, narrative discourse and text cohesion, is significantly less in the hearing impaired children than in normally hearing children. However, the most interesting finding was in the analysis of proportions. The proportional usage of types of propositions and cohesions to the total productivity of propositions and cohesions was different in the hearing impaired subjects as compared with the normally hearing subjects. The exact nature of this difference will be discussed in the succeeding sections.

Question II.

Is there a significant difference between age groups on all measures? Is this difference in age group performance developmental in nature? As predicted an overall age difference was found in three of the analyses, those which investigated various types of productivity. The analysis of clause development demonstrated age differences across all levels which were both linear and quadratic. Therefore, these components of the syntactic aspect of written language are clearly

of micro propositions to total propositions, macro propositions to total propositions, semantic cohesions to total cohesions and syntactic cohesions to total cohesions, did not differ by age. The difference in this proportional usage found according to handicapping condition, does not appear to be related to developmental differences present between ages ten and fourteen. Such differences, however, cannot be termed disorders, since the exact development of these language abilities prior to the age of ten years is not yet known.

In general, syntactic age differences appear to be characterized by a linear development. Semantic skills while characterized by age differences follow a quadratic trend. There is only a slight evidence of a linear component on the variable of micro propositions. This variable by definition appears highly interactive with the syntactic component of language (Turner and Green, 1978).

Question III.

Is there a significant interaction between handicapping condition and age? It was hypothesized that the age trends demonstrated by normally hearing children will also be demonstrated by hearing impaired children.

In three analyses, analysis of clause development, analysis of types, and analysis of proportions, there was no significant interaction between handicapping condition and age. Age differences or lack of age differences found in the hearing impaired were also found in the normally hearing sample. Although the two groups differed in performance on the language measures, these differences represented parallel performance. Hearing impaired children, then, are depressed with respect to overall productivity. However, the changes in this productivity at each age level are representative of changes also seen within the normally hearing population.

There was a significant interaction of handicapping condition and age for the analysis of total productivity. This was caused by the age twelve group. They were

the most productive group within the hearing impaired sample, but the least productive within the normally hearing sample. An explanation for this unusual finding seems ~~to be~~ that the effects of puberty are related to age span not specific years.

Question IV.

Do the language measures differ significantly from one another? It was hypothesized that the language measures would provide unique information. The measure factor for all four analyses were highly significant, indicating that the components of each analysis looked at a different aspect of the overall language function within the written narrative discourse of the entire sample. The significant findings on all four analyses support the hypotheses that these are different aspects of language functioning.

Question V.

Is there a significant interaction between measures and age? It was hypothesized that the age trends for all measures would be similar. There was no significant interaction between measure and age on either the analysis of clause development or the analysis of proportions. The age trends for all measures of syntax ability were similar. Since no significant differences by age were found in the analysis of proportions, age was not significant for any proportion. However, there was a significant interaction between measures and age for the analysis of total productivity and the analysis of types. Although significant differences in age groups were found for total cohesions and total words, there was no age effect for total proposition production. Similarly, several language measures included within the analysis of types did not differ according to age. Only six of the eight variables demonstrated age level differences: number of subordinate clauses, number of T-units, number of macro propositions, number of micro propositions, number of

reference cohesions and number of lexical repetition cohesions. All six demonstrated quadratic age trends. Linear and quadratic trends were evident for number of subordinate clauses and micro propositions. Collocation cohesions, demonstrated neither a quadratic nor linear trend. No age effects were present for conjunction cohesions. Again, these results reiterate that syntactic structures have a tendency to develop linearly, while the semantic measures are characteristicly quadratic in form.

Question VI.

Is there a significant interaction between measures and handicapping condition? The significance of the measures and handicapping condition interaction provides perhaps the most interesting information about the language of hearing impaired children.

Clause development will be discussed first. Hearing impaired children produced fewer words per T-unit, fewer words per main clause, fewer words per subordinate clause, fewer adverbs of time, fewer gerunds, infinitives and participles and fewer prepositional phrases than their normally hearing peers. However, they produced similar amounts of modals, be-have forms in the auxiliary and possessive nouns and pronouns. It is important to note that most hearing impaired children did not use the have-form in the auxiliary, but used primarily the present progressive, -is verbing form. The possessive form was primarily through possessive pronouns, his/hers, and the modal used was primarily /will/ use in the future tense. Since overall production of total words was significantly less in the hearing impaired sample than in the normally hearing sample, the usage of present progressives, future tense and possessive pronouns in written language must be proportionately higher in their written language than that of their normally hearing peers. Errors or deviances were not as characteristic as the total omission of

structure within the writing sample.

Proposition differences with respect to total productivity were not statistically significant when comparing normally hearing and hearing impaired children. This represents an important finding, particularly in view of the fact that significant differences were found in total productivity of words. Hearing impaired children deliver a similar amount of meaningful units, in toto, when compared to their normally hearing peers. However, they use far fewer words to do so. The variety and quantity of syntactic forms is also significantly less within the hearing impaired subjects as compared to normally hearing subjects. Therefore, the language then generated is similar to telegraphic language, where content of information is delivered concisely and directly. Proportionately, hearing impaired children use more macro propositions than their normally hearing controls. For example, they are concerned with delivering the message: the car hit the boy. It does not seem critical to describe the car, or the driver, how the car hit, or any specific details about the boy. Normally hearing children, on the other hand, use a greater proportion of micro propositions in their narrative discourse. There are more descriptors related to temporal characteristics, qualitative characteristics and location, providing the reader with specifics about the situation described. The use of micro propositions requires more facility with syntactic forms. In summary, language is more elaborate within a normally hearing population than in a hearing impaired population. This does not mean that hearing impaired children produce more information within their stories than normally hearing children of the same age. Hearing impaired children produced significantly fewer macro propositions and micro propositions than the normally hearing children.

There were also significant differences between the two groups according to their use of cohesive devices within the written text. Hearing impaired children

produce less redundancy and linkage within the text. The quantity of cohesive devices is much less prominent within the hearing impaired written sample. Information in the text often does not require the use of cohesive devices, since the information may not necessarily need to be related to previous chunks of informaiton. Each idea presented is an independent and complete unit of information, not necessarily relying upon understanding of the information previously delivered. Hearing impaired children use only a small variety of cohesive devices. Interestingly, although the total number of cohesions is significantly less within a hearing impaired population, the number of reference cohesions, lexical repetitions and conjunctions were not statistically different when compared to that of their normally hearing peers. Hearing impaired children use many pronouns and demonstratives in their written language. They repeat lexically. "The boy" is referred to repeatedly as "the boy." Conjunctions were primarily additive "and" conjunctions.

An observation about the data obtained from the written language samples was that absence of structure was more characteristic than incorrect usage of structure. There were only two children of the forty-nine hearing impaired children who used the cohesive forms of substitution or ellipsis. Collocations were minimally used, and often absent. The use of synonyms, superordinates, antonyms, or metaphors was so delayed that often only one or two instances could be recorded, even in samples over one hundred words in length.

The use of collocation types should be further investigated within the hearing impaired population's written language. Error analysis of the use of demonstratives and pronouns, although probably not providing novel information to the field, would reiterate what other studies have reported concerning the difficulties hearing impaired children evidence with these syntactic forms. Proportional usage of

cohesive devices should not include the use of lexical repetitions with the use of collocation since the excessive use of repetition tends to mask the effect of collocation use.

Question VII.

Is there a significant interaction between age, handicapping condition and language measures? The general findings of this research, Phase One, are that hearing impaired children differ from normally hearing children of the same age by producing significantly fewer syntactic and semantic forms within their written language. Normally hearing and hearing impaired children do not differ by age groups, but are similar regardless of age. Although some differences were found according to language measure, they were common to all five age groups. For example, when hearing impaired children produced similar quantities of certain semantic or syntactic forms, this finding was consistent across all ages. In only one analysis was a significant interaction between age, handicapping condition and language measures found. Again, the group of hearing impaired twelve-year-olds performed better than the normally hearing group of twelve-year-olds with respect to productivity of total propositions.

In summary, while hearing impaired children produce quantities of overall units of meaning similar to their normally hearing peers, they are severely delayed in the development of the syntax skills with which they can communicate these ideas. Additionally, they lack a variety of either semantic or syntactic tools for conveying information. This is characteristically referred to as the "stereotypic language" of hearing impaired children. Overall, their use of cohesion is dependent primarily upon three types of devices, demonstratives, pronouns and lexical repetition. The hearing impaired children produce proportionally more macro propositions than the normally hearing children. However, this dissertation does

not provide information regarding the exact nature of the macro propositions used, nor the cohesiveness of the macro propositions required for the formation of a good story. Further investigation is warranted about the story grammar structure and types of macro propositions employed within the written language of the hearing impaired. Since linear development of cohesion and propositions was not demonstrated, the development of these skills in oral narrative discourse, or in beginning writing ability must be studied. Perhaps the development of semantic language skills occurs prior to the development of written language. The art of story telling and the understanding of the cohesiveness of the stories may occur between the ages of three and seven. The development of these skills can be measured within the written language of children after they have mastered decoding skills, or phonics, spelling, punctuation, grammar and syntax rules. However, the skills measured may simply represent the development of semantic skills acquired in oral/total communication receptive and expressive language. The findings of this dissertation are just an initial step in the understanding of the development of meaning within stories in the hearing impaired children. Only further research can answer the above questions.

Discussion of Phase Two

Phase One provided information about the differences and similarities of the syntactic and semantic language measures employed for this research project. The relationship between these language measures and the reading ability of hearing impaired children could not be investigated successfully through the research design of Phase One. Phase Two was designed to examine relationship between reading and writing abilities in hearing impaired children matched with normally

hearing children.

When hearing impaired school-aged children between the ages of ten and fourteen were matched with their normally hearing peers on the basis of performance on the Paragraph Comprehension subtest of the Woodcock-Johnson Psychoeducational Battery and chronological age, all differences on the written language measures between groups, due to handicapping condition, disappeared. The cloze procedure for evaluating reading was not intended as an indepth examination of the reading process, but was an indication of a general ability level of reading comprehension.

However, most commonly, hearing impaired children are matched on the basis of reading level with normally hearing children who are chronologically much younger. When the hearing impaired children were matched to normally hearing children on the basis of reading level, again using the cloze procedure, but not age, and the normally hearing children were at least three years younger than the hearing impaired children, some differences in performance on the written language measures were found. Syntactic abilities, which were shown to be related to age in a linear fashion, also were more related to age than reading comprehension. Older children demonstrated better syntactic ability than younger children, even when the older children had severe and profound hearing losses.

These findings replicate and extend the results of the four analyses of Phase One. Syntactic structures follow a strong linear development, whose slope is less steep in hearing impaired children's written language development. Semantic written language structures, on the other hand, are predominantly quadratic in function, at least between the ages of ten and fourteen. Semantic written language abilities are less affected by age differences than the syntactic written language abilities. While words per T-unit is an efficient and quick method of evaluating the

written language of children, this method appears to have a greater relationship to age than to reading comprehension ability.

Phase Two substantiates the claim that there is a strong relationship between the written language skills and reading abilities of hearing impaired children. Until now, this relationship has never been demonstrated. Semantic written language variables appear more related to reading comprehension than syntactic written language variables.

The implications of these findings are that the semantic characteristics of written language provide valuable information regarding difficulties with reading. Gains, Mandler and Bryant (1981) found that hearing impaired children recalled confused stories better than normally hearing children. The findings of this research were that hearing impaired children do not have versatility or variety when using text cohesive devices. They tend to use lexical repetition or pronouns to the exclusion of all other cohesive devices. Each meaningful statement appears independent of what preceded and what follows within the text. Since individual segments are considered as individual units of meaning, it is not surprising that hearing impaired children can retain more information from confused stories than their normally hearing peers. The information, cohesion, of the whole text must be meaningful for normally hearing children to retain information from their reading. It is critical to investigate whether current methods of remediating language of the hearing impaired which emphasize the unit of the sentence and the components of the sentence, teach segmentation to such an extent that the pieces are more important to hearing impaired children than the whole.

Again, the close relationship between semantic written language variables and reading necessitates a thorough investigation of the types of macro propositions and the linkage of macro propositions within the written texts of

hearing impaired children with techniques such as the story grammar analysis of Stein (1982).

The possibility of teaching syntactic structures through semantics may be a viable alternative to present programming of educational curriculums. It is further hypothesized that connective devices within a text and cohesion within a text must be understood, before the use of syntactic structures can be truly understood. The communication of the same unit of meaning through a variety of syntactic structures cannot be functional unless a child appreciates the utility of such devices. Phrase structure rules and concepts of embedding must first be understood on the level of what units of meaning are conveyed. Sentence combining techniques are, therefore, both syntactic and semantic. The absence of certain structures within the written language of hearing impaired children may be directly related to the fact that hearing impaired children are oblivious to the role these structures play within the written narrative discourse. If the function is not appreciated receptively, it cannot possibly be incorporated expressively in the communication process.

The implications of this research for educational practice are that syntactic structures alone will not improve reading ability. Improved syntactic ability is not synonymous with reading comprehension. A close relationship between semantic ability and reading comprehension exists.

Discussion of Phase Three

Phase Two provided information about the relationship of written language variables to reading comprehension. Phase Three provided information about the relationship between the chosen written language variables and current information

used to identify and classify hearing impaired children, hearing ability, speech intelligibility, performance intelligence, age, receptive syntactic ability both in oral/total communication and in written language.

Are the semantic and syntactic written language variables simply repetitive or redundant to information already available about hearing impaired chidlren? The results of Phase Three indicated that semantic written language variables do indeed provide information other than what is currently known about hearing impaired children. In fact, these semantic written language variables are more sensitive to the variability within the hearing impaired population than other measures currently utilized. The factor analysis divided semantic factors and syntactic factors into two distinct units. Syntax components, such as the test of syntactic ability and the test of auditory comprehension of language, as well as words per T-unit, measure a particular language ability common to both receptive and expressive forms of language. Language abilities, both semantic and syntactic, are distinct factors from hearing ability and speech intelligibility. Within a sample of hearing impaired children with performance intelligence at least 80, and when other handicapping conditions are absent, age and performance intelligence account for very little of the variability within the population.

If the purpose of diagnostic tools is to differentiate the high degree of variability of language skills within the hearing impaired population, then more emphasis must be placed upon semantic language variables. It is possible that measures of receptive vocabulary, or expressive vocabulary whether in the oral/total communication or written modes, may be more similar to the semantic component of language than the syntactic component. Such a measure was not available for this analysis. Additionally, discussion about hearing impairment and language must clearly separate semantic and syntactic abilities since they are not

the same aspect of language. Auditory ability and speech intelligibility are not synonymous to language.

There may be subtypes of language deficits within a hearing impaired or normally hearing population. Perhaps there is such a thing as a semantic deficit, not necessarily related to a syntactic deficit and vice versa. The primary contribution of Phase Three is that semantic written language variables, measured through propositional analysis and text cohesion, are extremely sensitive to the variance within the hearing impaired population.

This research provides more questions than answers. A new direction in emphasis within written language research for both hearing impaired children and normally hearing children is warranted. It is important to know that the concept of language must be expanded and that language competence is not completely understood. In fact, there remains as yet an unexplored region of study, emphasis on the meaning of the whole, rather than dissection of the parts. Such an emphasis on semantics has implication for studies of reading, studies of written language, and studies of oral and signed language. There is much more unknown about semantic variables than is known. The use of written language may provide a quick, accurate and useful tool for diagnostically assessing the language problems of hearing impaired children in relation to their reading.

APPENDICES

APPENDIX I

Table XXXV

Turner & Greene, 1977

Propositional Analysis of Narrative Discourse

Sample from Pilot Study

1. is worried, man 2
2. because, 1, 3
3. run over, man, boy, car
4. his, car, 3
5. fly out, papers, motorcycle
6. of B, motorcycle, 5
7. come, ambulance, 8
8. is inside, m., ambulance
9. come, police
10. also, 9
11. set, drs., boy, wheels
12. loc: in bed, 11
13. bring, drs., 02
14. for, 13, 15
15. breathe, boy, 02
16. is worried, mother, boy
17. of boy, mother, 16
18. take a look, policeman, boy
19. wrap, drs., boy, blanket
20. get ready, drs., boy
21. purpose, 20, 22
22. go, boy
23. loc: to hospital, 22

Total Number of Propositions: 23

Propositions/T-unit: 23/9

Table XXXVI

Syntactic Density

		Loading	Frequency	L x F
1.	Words per T-unit	.95		
2.	Subordinate clauses/T-unit	.90		
3.	Main clause word length (mean)	.20		
4.	Subordinate clause word length	.50		
5.	Number of modals (will, shall, can, may, must, would...)	.65		
6.	Number of "be," "have" forms in the auxiliary	.40		
7.	Number of prepositional phrases	.75		
8.	Number of possessive nouns and pronouns	.70		
9.	Number of adverbs of time (when, then, once, while...)	.60		
10.	Number of gerunds, participles and absolute phrases (unbound modifiers)	[illegible]		

SDS: Syntactic Density Score (Total/Number of T-units)

Grade Level Conversion Table:

SDS	.5	1.3	2.1	2.9	3.7	4.5	5.3	6.1	6.9	7.7	8.5
Grade	1	2	3	4	5	6	7	8	9	10	11
SDS	9.3	10.1	10.9								
Grade	12	13	14								

Table XXXVII

Analysis of Cohesion

Halliday & Hasan, 1976 (adapted)

T-unit No.	No. of Ties	Cohesive Item	Type of Cohesion	Presupposed Item
1.	2	A-he	RP	man
		A-his	RP-U	man
2.	1	A-his	RP-U	boy
3.	3	A-and	C-U	--
		A-his	RP	boy
		A-ambulance	LR	ambulance
4.	0			
5.	5	A-the	RD	boy
		A-boy	LR	boy
		A-and	C	doctors
		A-and	RD	boy
		A-boy	LR	boy
6.	4	A-the	RD	boy
		A-boy's	LR	boy
		A-mother	LR	mother
		A-him	RP	boy
7.	4	A-the	RD	police
		A-policeman	LR	police
		A-the	RD	boy
		A-boy	LR	boy
8.	2	A-and	C	doctors
		A-him	RP	boy
9.	1	A-they	RP	doctors

LEGEND:
A=anaphoric
RP=reference/pronominal
C=conjunction
RD=reference/demonstrative
LR=lexical repetition
coll=collocation
U=unclear

APPENDIX II

Table XXXVIII

Two Factor Repeated Measures Analysis of Variance

Clause Development

Groups Matched by Reading and Age

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Subjects	4988.9	1,16	4988.9	124.82	.0000**
Handicapping Condition	4.98	1,16	4.98	.12	.7287
Error	639.5		39.97		
Measures	1561.52	8,128	195.19	22.09	.0000**
Measures x Handicapping Condition	62.63	8,128	7.83	.89	.5304
Error	1131.13		8.84		

* = p <.05
** = p <.01

Table XXXIX

Two Factor Repeated Measures Analysis of Variance

Proportions

Groups Matched by Reading and Age

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Subjects	155402.	1,16	155402.	10178.29	.0000**
Handicapping Condition	3.51	1,16	3.51	.23	.6382
Error	244.29		15.27		
Measures	8845.29		2211.27	40.02	.0000**
Measures x Handicapping Condition	26.36	4,64	6.59	.12	.9752
Error	3536.61		55.26		

* = p <.05
** = p <.01

Table XL

Two Factor Repeated Measures Analysis of Variance

Types

Groups Matched by Reading and Age

Source	Sum of Squares	df	Mean Square	F-Values	Tail Proba-bility
Subjects	36608.4	1,16	36608.4	44.31	.0000**
Handicapping Condition	20.25	1,16	20.25	.02	.8775
Error	13218.06		826.13		
Measures	19047.4	7,112	2721.06	25.22	.0000**
Measures x Handicapping Condition	282.31	7,112	40.33	.37	.9159
Error	12085.5		107.91		

* = $p < .05$
** = $p < .01$

Table XLI

Two Factor Repeated Measures Analysis of Variance

Total Productivity

Groups Matched by Reading and Age

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Subjects	314646.	1,16	314646.	45.73	.0000**
Handicapping Condition	696.96	1,16	696.96	.10	.7544
Error	110088.37		6880.52		
Measures	64677.0	2,32	32338.5	41.05	.0000**
Measures x Handicapping Condition	314.48	2,32	157.24	.20	.8201
Error	25207.19		787.72		

* = p <.05
** - p <.01

Table XLII

Two Factor Repeated Measures Analysis of Variance

Proportions

Groups Matched by Reading Only

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Subjects	137038.	1,14	137038.	8411.89	.0000**
Handicapping Condition	.87	1,14	.87	.05	.8209
Error	228.07		16.29		
Measures	10548.0	4,56	2636.99	53.47	.0000**
Measures x Handicapping Condition	295.61	4,56	73.90	1.50	.2150
Error	2761.57		49.31		

* = $p < .05$
** = $p < .01$

Table XLIII

Two Factor Repeated Measures Analysis of Variance

Types

Groups Matched by Reading Only

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Subjects	19281.6	1,14	19281.6	36.67	.0000**
Handicapping Condition	815.07	1,14	815.07	1.55	.2336
Error	7361.98		525.86		
Measures x Handicapping Condition	455.49	7,98	65.07	1.10	.3707
Error	5808.64		59.27		

* = p <.05
** = p <.01

Table XLIV

Two Factor Repeated Measures Analysis of Variance

Total Productivity

Groups Matched by Reading Only

Source	Sum of Squares	df	Mean Square	F-Values	Tail Probability
Subjects	177512.	1,14	177512.	36.21	.0000**
Handicapping Condition	9775.52	1,14	9775.52	1.99	.1797
Error	68624.46		4901.75		
Measures	34440.5	2,28	17220.3	33.26	.0000**
Measures x Handicapping Condition	2465.17	2,28	1232.58	2.38	.1110
Error	14497.67		517.77		

* = $p < .05$
** = $p < .01$

Table XLV

Modals

	Age	Mean	SD	Range
Hearing Impaired	10	1.1	.7	0-3
	11	1.9	1.3	0-5
	12	3.3	3.5	0-10
	13	1.7	1.5	0-5
	14	.97	.5	0-3
Normally Hearing	10	.4	.52	0-1
	11	1.7	2.4	0-6
	12	1.5	1.6	0-5
	13	4.2	6.2	0-22
	14	1.0	1.1	0-3

Table XLVI

Total Be-Have Auxiliaries

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	3.1	2.51	0-7
	11	2.86	1.77	0-5
	12	5.92	5.31	2-26
	13	3.54	2.88	0-32
	14	3.44	2.55	0-6
Normally Hearing	10	2.2	1.8	1-6
	11	3.8	3.5	0-10
	12	6.4	3.9	1-11
	13	13.5	21.7	2-81
	14	5.6	2.7	3-11

Table XLVII

Total Prepositional Phrases

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	4.6	5.74	0-19
	11	4.43	2.64	0-6
	12	10.6	9.71	2-26
	13	7.54	8.08	0-32
	14	6.11	3.06	1-12
Normally Hearing	10	5.4	2.9	1-10
	11	7.	5.7	3-16
	12	9.8	5.0	2-15
	13	8.9	6.9	6-37
	14	11.	8.6	4-21

Table XLVIII

Total Possessives

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	2.2	2.39	0-7
	11	2.14	1.68	0-4
	12	5.31	4.59	0-13
	13	2.38	2.87	0-8
	14	1.67	1.94	0-3
Normally Hearing	10	2.2	1.8	0-5
	11	3.0	2.1	1-7
	12	3.4	2.3	0-7
	13	6.4	4.9	0-19
	14	4.1	4.6	0-14

Table XLIX

Total Adverbs of Time

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	[illegible]	1.23	0-4
	11	.286	.49	0-1
	12	1.77	1.69	0-5
	13	1.54	2.76	0-8
	14	.89	.78	0-2
Normally Hearing	10	2.1	1.7	0-12
	11	4.7	5.3	1-15
	12	3.9	3.4	0-13
	13	5.0	3.3	1-11
	14	4.4	1.7	2-7

Table L

Total Gerunds and Infinitives

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	1.7	3.74	0-12
	11	1.14	1.46	0-4
	12	2.92	2.93	0-9
	13	2.0	2.71	0-10
	14	3.11	2.52	1-4
Normally Hearing	10	1.9	2.0	0-6
	11	3.7	5.1	0-13
	12	3.5	1.9	0-6
	13	7.5	6.2	2-22
	14	4.4	2.5	0-8

Table LI

Total Subordinate Clauses

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	2.1	3.34	0-11
	11	3.29	2.56	0-17
	12	4.77	4.62	0-15
	13	3.0	3.44	0-12
	14	3.11	2.32	0-5
Normally Hearing	10	1.6	1.5	0-5
	11	3.2	4.4	0-12
	12	6.5	3.5	2-12
	13	7.2	8.6	2-34
	14	6.	3.5	2-13

Table LII

Total Words

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	77.7	56.3	32-226
	11	89.9	29.7	34-134
	12	150.2	78.1	34-287
	13	103.0	69.5	23-296
	14	80.9	18.9	36-102
Normally Hearing	10	72.8	36.5	33-134
	11	147.	110.	41-310
	12	131.2	58.8	53-231
	13	246.9	206.5	86-791
	14	152.4	75.6	70-281

Table LIII

Syntactic Density Score

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	1.89	1.09	.6-4.2
	11	1.79	.69	1.1-2.9
	12	1.66	.42	1.0-2.4
	13	2.37	1.59	.99-7.0
	14	2.36	1.01	1.1-4.0
Normally Hearing	10	2.2	.77	1.3-3.6
	11	2.0	.55	1.5-2.8
	12	2.9	1.2	1.5-4.6
	13	2.9	1.3	1.5-5.7
	14	3.5	1.3	1.7-5.9

Table LIV

Total Cohesions

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	28.7	16.6	13-68
	11	38.3	13.4	15-57
	12	62.2	34.3	11-122
	13	41.8	30.9	10-126
	14	33.1	9.36	14-40
Normally Hearing	10	28.7	14.2	11-54
	11	52.3	34.9	17-108
	12	42.9	20.0	17-80
	13	67.3	41.6	31-184
	14	47.0	19.5	25-70

Table LV

Lexical Repetition

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	7.5	5.6	1-18
	11	8.43	5.19	2-15
	12	17.85	14.15	0-57
	13	10.77	8.83	1-24
	14	8.4	4.01	0-16
Normally Hearing	10	5.0	3.6	0-10
	11	8.2	4.9	3-15
	12	7.5	7.1	0-24
	13	15.2	16.4	2-61
	14	7.1	6.7	1-20

Table LVI

Conjunctions Cohesions

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	3.0	1.94	0-6
	11	4.71	3.64	1-12
	12	8.76	8.19	0-29
	13	6.23	4.69	1-15
	14	6.0	3.97	1-7
Normally Hearing	10	5.9	3.2	3-13
	11	9.8	1.5	5-23
	12	6.6	3.4	1-14
	13	11.7	7.7	4-32
	14	6.6	2.8	3-11

Table LVII

Lexical Collocations

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	2.9	2.88	0-8
	11	4.14	2.54	0-8
	12	4.31	3.28	0-11
	13	2.92	3.93	0-15
	14	3.2	2.35	1-8
Normally Hearing	10	3.2	1.9	0-6
	11	8.2	4.9	3-15
	12	4.5	3.3	1-10
	13	9.4	7.7	4-32
	1	8.3	3.2	3-13

Table LVIII

Reference Cohesions

	Age	Mean	)	Range
Normally Hearing	10	15.6	7.9	5-35
	11	25.8	19.6	9-60
	12	25.0	9.6	13-45
	13	31.1	14.4	14-62
	14	25.4	11.4	12-48
Hearing Impaired	10	15.4	8.7	7-31
	11	21.7	6.7	9-29
	12	31.0	14.0	10-53
	13	22.4	17.4	7-36
	14	16.25	5.5	8-23

Table LIX

Normally Hearing and Hearing Impaired Children

Analysis of Total Productivity

		Total Words	Total Propositions	Total Cohesions
Normally Hearing	Mean	147.6	64.2	48.0
	SD	119.8	67.3	29.7
	Range	(33-791)	(5-429)	(11-184)
Hearing Impaired	Mean	105.1	45.9	43.1
	SD	65.9	32.9	27.7
	Range	(23-296)	(6-135)	(10-126)

Sub
Clauses

[illegible]

Table LXIII

Words Per T-Unit

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	6.86	2.29	4.2-10.7
	11	7.72	1.34	6.1-10.1
	12	7.83	1.64	4.9-10.3
	13	7.94	2.74	5.0-12.9
	14	8.35	1.71	6. -11.25
Normally Hearing	10	7.5	1.2	5.8-9.6
	11	8.9	1.7	5.9-10.3
	12	10.5	2.8	5.0-15.3
	13	11.5	3.5	6.8-18.8
	14	12.3	2.3	8.3-15.7

Table LXIV

Subordinate Clause Word Length

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	2.96	2.79	0-7.5
	11	2.5	4.3	0-6.3
	12	3.9	1.87	0-5.9
	13	3.79	2.17	0-7.3
	14	4.55	3.09	0-10
Normally Hearing	10	4.4	2.9	0-9
	11	3.8	2.5	0-7.3
	12	5.6	1.3	2.1-7.7
	13	6.4	1.4	4.0-8.4
	14	3.9	2.3	0-6

Table LXV

Subordinate Clauses Per T-Unit

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	.16	.19	0-.52
	11	.26	.23	0-.7
	12	.43	.67	0-.9
	13	.38	.38	0-.52
	14	.21	.23	0-.71
Normally Hearing	10	.14	.11	(0-.36)
	11	.16	.13	0-.38
	12	.50	.19	.27-.91
	13	.47	.34	.15-1.33
	14	.51	.24	.18-.87

Table LXVI

Main Clause Word Length

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	5.84	1.44	4-8.4
	11	6.49	1.32	4.6-8.5
	12	6.84	1.32	4.9-9.9
	13	5.88	3.8	1.4-14.3
	14	7.43	1.49	5.6-9.6
Normally Hearing	10	6.0	2.1	5.4-8.3
	11	8.1	1.2	5.9-9.2
	12	5.2	1.9	2.9-12.1
	13	8.8	12.1	5.5-12.4
	14	9.2	1.3	7.3-10.6

Table LXVII

Total Micro Propositions

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	17.2	17.8	2-64
	11	17.7	6.7	7-23
	12	39.7	25.2	3-74
	13	26.5	23.6	1-95
	14	16.9	4.99	11-25
Normally Hearing	10	21.3	15.2	10-55
	11	47.3	40.8	11-107
	12	45.2	22.1	12-77
	13	75.7	77.9	29-312
	14	47.0	28.1	16-98

Table LXVIII

Total Macro Propositions

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	14.5	10.9	5-43
	11	19.3	6.3	10-30
	12	29.9	18.6	7-61
	13	18.2	8.96	7-32
	14	14.5	3.44	11-18
Normally Hearing	10	14.6	6.3	5-25
	[illegible]	26.8	19.9	7-59
	[illegible]	25.6	13.9	5-47
	13	40.0	28.4	16-117
	14	28.3	14.3	12-52

Table LXIX

Total Propositions

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	31.7	28.36	9-107
	11	37.0	11.4	17-53
	12	69.0	42.0	10-135
	13	44.6	30.2	6-122
	14	31.4	6.8	26-39
Normally Hearing	10	37.9	18.7	15-80
	11	74.2	60.6	23-166
	12	70.8	33.9	32-118
	13	115.7	105.3	45-429
	14	75.3	41.8	28-150

Table LXX

Semantic Cohesions/Total Cohesions

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	.36	.11	.15-.46
	11	.31	.09	.20-.38
	12	.32	.14	.21-.55
	13	.31	.15	.14-.58
	14	.36	.09	.07-.43
Normally Hearing	10	.26	.09	.09-.38
	11	.31	.09	.18-.45
	12	.26	.10	.06-.43
	13	.32	.14	.07-.52
	14	.32	.11	.14-.47

Table LXXI

Syntactic Cohesions/Total Cohesions

	Age	Mean	Standard Deviation	Range
Normally Hearing	10	.75	.09	.62-.91
	11	.70	.09	.55-.82
	12	.73	.11	.58-.94
	13	.68	.14	.48-.93
	14	.68	.11	.53-.86
Hearing Impaired	10	.64	.23	.47-.79
	11	.70	.09	.62-.80
	12	.65	.11	.45-.79
	13	.68	.16	.39-.83
	14	.65	.13	.50-.93

Table LXXII

Macro Proportions/Total Proportions

	Age	Mean	Standard Deviation	Range
Hearing Impaired	10	.50	.15	.31-.78
	11	.53	.08	.47-.66
	12	.45	.10	.30-.70
	13	.46	.15	.22-.83
	14	.47	.08	.36-.62
Normally Hearing	10	.39	.08	.31-.53
	11	.39	.06	.32-.48
	12	.36	.07	.20-.41
	13	.37	.05	.27-.46
	14	.39	.07	.27-.52

Table LXXIII

Micro Propositions/Total Propositions

	Age	Mean	SD	Range
Normally Hearing	10	.61	.08	.47-.69
	11	.61	.06	.52-.68
	12	.64	.07	.55-.80
	13	.63	.05	.54-.73
	14	.47	.28	.48-.73
Hearing Impaired	10	.5	13.16	.22-.69
	11	.45	.07	.34-.52
	12	.55	.10	.30-.70
	13	.54	.15	.17-.78
	14	.53	.09	.38-.64

Table LXXIV

Paragraph Comprehension

Age		Hearing Impaired	Normal Hearing
10	SD	4.2	4.6
	Mean	9.0	15.7
	Range	(4-17)	(12-25)
11	SD	3.7	3.0
	Mean	8.2	19.0
	Range	(7-12)	(14-23)
12	SD	4.2	3.9
	Mean	10.7	19.0
	Range	(5-18)	(16-23)
13	SD	5.6	1.9
	Mean	11.3	20.8
	Range	(8-22)	(18-24)
14	SD	4.0	2.3
	Mean	11.9	20.6
	Range	(6-19)	(19-23)

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